

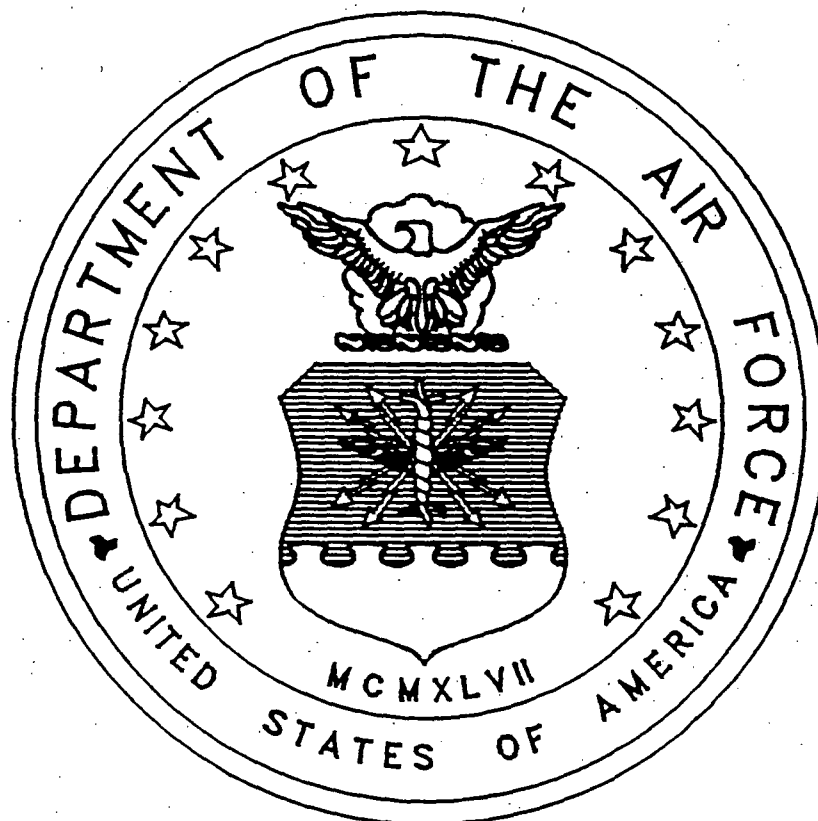
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UNITED STATES AIR FORCE

INSTALLATION RESTORATION PROGRAM



RECORD OF DECISION FOR PRIORITY 2 SITES
AT FAIRCHILD AIR FORCE BASE, WASHINGTON

FINAL

SEPTEMBER 1995

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NOTICE

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Record of Decision for Priority 2 Sites
at Fairchild Air Force Base, Washington

Final

Prepared by:

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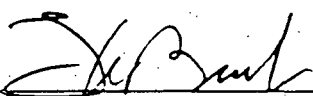
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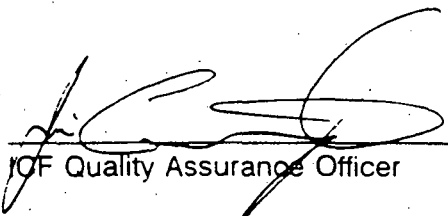
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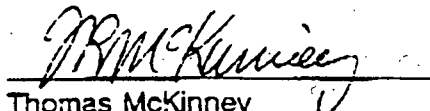
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PREFACE

This report presents the record of decision for the Priority 2 sites at Fairchild Air Force Base, Spokane County, Washington.

This report was prepared in September 1995. Mr. Michael Benavides is the Air Force Center for Environmental Excellence (AFCEE) Contracting Officer. Mr. Jonathan Haliscak of AFCEE provided technical oversight for this activity.

Approval:


Thomas McKinney
Program Director
ICF Technology Incorporated

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DECLARATION OF THE RECORD OF DECISION

SITE NAMES AND LOCATIONS

***Fairchild Air Force Base
Spokane County, Washington***

This document is the record of decision for the following 20 on-base Priority 2 Sites at Fairchild Air Force Base (Fairchild AFB) located in Spokane County, Washington. United States Air Force (Air Force) designations for these sites are in parentheses.

- Site FT-2 (FT-32), Former Fire Training Area;
- Site IS-2 (SS-30), Former Civil Engineering Warehouse;
- Site IS-3 (OT-16), Reciprocating Engine Shop, Building 2150;
- Site IS-4 (OT-17), Jet Engine Test Stand, Building 3000;
- Site PS-1 (ST-06), Bulk Fuel Storage Area;
- Site PS-3 (SS-07), Area C Pumphouse, Building 159;
- Site PS-4/PS-9 (SS-08), Pumphouse B, KC-135 Crash Site;
- Site PS-5 (SS-09), Fuel Oil Storage Tank at Wherry Housing;
- Site PS-7 (ST-10), Deep Creek Steam Plant, Building 1350;
- Site PS-10 (SD-31), Fuel Truck Maintenance Facility, Building 1060;
- Site SW-2 (DP-20), Waste Disposal Area Northeast of Wherry Housing;
- Site SW-3 (DP-21), Demolition Waste Disposal Area;
- Site SW-4 (DP-22), Former Coal Storage Area;
- Site SW-5 (OT-23), Former Incinerator at DRMO Yard;
- Site SW-7 (DP-24), Asphalt Waste Pile Area;
- Site SW-9 (RW-25), Radioactive Waste Disposal Area;
- Site SW-10 (DP-12), Disposal Area Near Jet Engine Test Stand;
- Site SW-11 (DP-13), Former Aircraft Reclamation Yard at Wherry Housing;
- Site SW-12 (DP-14), Disposal Area East of Weapons Storage Area; and
- Site WW-2 (WP-29), Waste Water Treatment Plant.

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial actions for the Priority 2 Sites, Fairchild AFB, Spokane County, Washington, which were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for this site.

The lead agency for this decision is the Air Force. The United States Environmental Protection Agency (EPA) approves of this decision and, along with the State of Washington Department of Ecology (Ecology), has participated in the scoping of the site investigations, the evaluation of the remedial investigation data, and the development of remedial alternatives. The State of Washington concurs with the selected remedies.

ASSESSMENT OF THE SITES

Actual or threatened releases of hazardous substances from the on-base Priority 2 Sites, if not addressed by implementing the response actions selected in the Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDIES

This ROD addresses soil and ground water contamination at the Priority 2 sites. This is the third of four RODs planned for Fairchild AFB. The first ROD, signed in February 1993, addressed contamination at the Craig Road Landfill Operable Unit. The second ROD, signed in June 1993, addressed contamination at the Priority 1 Operable Units. The fourth ROD will address the Priority 3 Sites.

The major components of the selected remedies for the 20 Priority 2 Sites are highlighted below. Further explanations regarding the remedial alternatives and selected remedies are located in sections 8.0, 9.0, and 10.0 of the ROD Decision Summary.

Limited Field Investigations (LFI) conducted by the Air Force concluded no further action was necessary at the following 12 sites:

- Site IS-2, Former Civil Engineering Warehouse;
- Site PS-3, Area C Pumphouse, Building 159;
- Site PS-4/PS-9, Pumphouse B, KC-135 Crash Site;
- Site SW-2, Waste Disposal Area Northeast of Wherry Housing;
- Site SW-3, Demolition Waste Disposal Area;
- Site SW-4, Former Coal Storage Area;
- Site SW-5, Former Incinerator at DRMO Yard;
- Site SW-7, Asphalt Waste Pile Area;
- Site SW-9, Radioactive Waste Disposal Area;
- Site SW-10, Disposal Area Near Jet Engine Test Stand;
- Site SW-12, Disposal Area East of Weapons Storage Area; and
- Site WW-2, Waste Water Treatment Plant.

The No Further Action Decision documents for the 12 no action sites and the Priority 2 sites LFI report can be found in the administrative record which is available for review.

Based on results of the LFI, the Air Force recommended a Remedial Investigation/Feasibility Study (RI/FS) for the remaining Priority 2 Sites, those of which with higher priority being referred to as Priority 2a Sites. An RI/FS was completed for the following eight Priority 2a Sites:

- Site IS-3, Reciprocating Engine Shop, Building 2150;
- Site IS-4, Jet Engine Test Stand, Building 3000;
- Site PS-1, Bulk Fuel Storage Area;
- Site PS-5, Fuel Oil Storage Tank at Wherry Housing;
- Site PS-7, Deep Creek Steam Plant, Building 1350;
- Site PS-10, Fuel Truck Maintenance Facility, Building 1060;
- Site SW-1 1, Former Aircraft Reclamation Yard at Wherry Housing; and
- Site FT-2, Former Fire Training Area.

The selected remedial actions for these eight Priority 2a Sites are:

Reciprocating Engine Shop, Building 2150 (IS-3)

The selected remedy at IS-3 is Institutional Controls. This decision is based on the results of the human health risk assessment, which determined that conditions at the site posed no unacceptable risks to human health or the environment. When Building 2150 is demolished, underlying soil will be assessed for polychlorinated biphenyls to assure compliance with state and federal regulations.

Jet Engine Test Stand, Building 3000 (IS-4)

The selected remedy is Institutional Controls and Monitoring. This remedy consists of the following elements:

- Maintaining institutional controls in the form of restricting site access and requiring a permit from the Fairchild AFB Civil Engineering Squadron for intrusive activities until cleanup levels are achieved; and
- Monitoring natural degradation of diesel range petroleum in site soil will continue until the contamination level decreases below the state cleanup standard which is protective of human health and the environment.
- Contaminants detected in the deep ground water beneath and up gradient of this site are not believed to be associated with this site and will be addressed under the Priority 3 Operable Units.

Bulk Fuel Storage Area (PS-1)

The goals of remedial action at PS-1 are to remediate ground water to state and federal levels and to remediate soil to state cleanup levels that are protective of ground water. The selected remedy for soil remediation is Open System Bioventing. The selected remedy for ground water is Institutional Controls and Monitoring. These alternatives consist of the following elements:

- Implementing an in-situ bioventing treatment system for diesel range petroleum contaminated soil;
- Maintaining institutional controls in the form of restricting site access and requiring a permit from the Fairchild AFB Civil Engineering Squadron for intrusive activities until state and federal based cleanup levels are achieved; and
- Monitoring site and down gradient ground water to assess natural degradation and migration of diesel range petroleum and benzene.

Fuel Oil Storage Tank at Wherry Housing (PS-5)

The goals of remedial action at PS-5 are to remediate ground water to state cleanup levels and to remediate soil to state cleanup levels that are protective of ground water. The selected remedy for soil is Institutional Controls. The selected remedy for ground water is Institutional Controls and Monitoring. These alternatives consist of the following elements:

- Maintaining institutional controls in the form of restricting site access and requiring a permit from the Fairchild AFB Civil Engineering Squadron for intrusive activities until state based cleanup levels are achieved.
- Monitoring site ground water and down gradient ground water to assess natural degradation and migration of diesel range petroleum.

Deep Creek Steam Plant, Building 1350 (PS-7)

The goals of remedial action at PS-7 are to remediate ground water to state cleanup levels and to remediate soil to state cleanup levels that are protective of ground water. The selected remedy for soil is Institutional Controls and for ground water is Institutional Controls and Monitoring. These alternatives consist of the following elements:

- Maintaining institutional controls in the form of restricting site access and requiring a permit from the Fairchild AFB Civil Engineering Squadron for intrusive activities until state cleanup levels are achieved. Remaining soil contamination will be addressed when the building is demolished; and
- Monitoring site ground water and down gradient ground water to assess natural degradation and migration of diesel range petroleum.

Fuel Truck Maintenance Facility, Building 1060 (PS-10)

The goal of remedial action at PS-10 is to remediate soil to state cleanup levels that are protective of ground water. The trichloroethylene (TCE) contamination detected in ground water at this site will be addressed under the Priority 3 Operable Unit. The selected remedies for soil are Excavation and Off-Site Disposal, and Institutional Controls and Monitoring. These alternatives consists of the following elements:

- Maintaining institutional controls in the form of restricting site access and requiring a permit from the Fairchild AFB Civil Engineering Squadron for intrusive activities until cleanup levels are achieved;
- Excavation and off-site disposal of approximately 67 cubic yards of TCE contaminated soils. Contaminated soils will be treated using high temperature incineration prior to disposal; and
- Monitoring natural degradation of diesel range petroleum in site soil will continue until the contamination level decreases below the state cleanup standard.

Former Aircraft Reclamation Yard at Wherry Housing (SW-1 1)

The Air Force has determined that no further remedial action is necessary at Site SW-1 1. This decision is based on the results of the human health risk assessment, which determined that conditions at the site posed no unacceptable chemical risks to human health or the environment.

Former Fire Training Area (FT-2)

The goals of remedial action at FT-2 are to remediate ground water and soil to state cleanup levels. The selected remedy for both soil and ground water is Institutional Controls and Monitoring. These alternatives consist of the following elements:

- Maintaining institutional controls in the form of restricting site access and requiring a permit from the Fairchild AFB Civil Engineering Squadron for intrusive activities until state cleanup levels are achieved.
- Monitoring of site soil and ground water and down gradient ground water to assess natural degradation and migration of diesel range petroleum.

STATUTORY DETERMINATIONS

The selected remedies are protective of human health and the environment, comply with Federal and State requirements that are legally applicable, or relevant and appropriated to the remedial action, and are cost effective. The remedies utilize permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfy the statutory preference for remedies which reduce contaminant toxicity, mobility, or volume as a principal element. Because the

remedial actions at Sites IS-3, IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2 may require five or more years to attain cleanup levels, a review of the selected remedies will be conducted for each of these sites within five years. The purpose of the five year review is to assure that the remedies remain protective of human health and the environment.

Signature for the foregoing On-Base Priority 2 Operable Unit Record of Decision by the United States Air Force with concurrence of the United States Environmental Protection Agency and the Washington State Department of Ecology.

Mary E. Burg

Mary E. Burg, Program Manager
Toxics Cleanup Program
Washington State Department of Ecology

20 Dec 1995

Date

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Signature for the foregoing On-Base Priority 2 Operable Unit Record of Decision by the United States Air Force with concurrence of the United States Environmental Protection Agency, and the Washington State Department of Ecology,

Chuck Clarke

Chuck Clarke
Regional Administrator, Region X
United States Environmental Protection Agency

12/20/95

Date

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Signature for the foregoing On-Base Priority 2 Operable Unit Record of Decision by the United States Air Force with concurrence of the United States Environmental Protection Agency, and the Washington State Department of Ecology;



CHARLES T. ROBERTSON, JR.
Lieutenant General, USAF
Air Mobility Command
Chairperson, Environmental Protection Committee

-7 FEB 1995

Date

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LIST OF ACRONYMS AND ABBREVIATIONS

Air Force	United States Air Force
ARAR	Applicable or Relevant and Appropriate Requirement
Battelle	Battelle Memorial Institute, Denver Operations
BDAT	Best Demonstrated Available Technology
CEE	Civil and Environmental Engineering
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRL	Craig Road Landfill
CRP	Community Relations Plan
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
Fairchild AFB	Fairchild Air Force Base
FFA	Federal Facilities Agreement
HQ	Hazard Quotient
IRP	Installation Restoration Program
JRB	JRB Associates
LFI	Limited Field Investigation
LDR	Land Disposal Restriction
MCL	Maximum Contaminant Level
MTCA	Model Toxics Control Act
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
O&M	Operations and Maintenance
OU	Operable Unit
PCB	Polychlorinated Biphenyl
POL	Petroleum, Oils, and Lubricant
RAO	Remedial Action Objective
RBSL	Risk Based Screening Level
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Records of Decision
SAIC	Science Applications International Company
SARA	Superfund Amendments and Reauthorization Act
TCE	Trichloroethylene
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

In March 1989, Fairchild Air Force Base (Fairchild AFB) was listed on the United States Environmental Protection Agency's (EPA) National Priorities List (NPL) of hazardous waste sites to be addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). In March 1990, the United States Air Force (Air Force), EPA, and the Washington State Department of Ecology (Ecology) signed a Federal Facilities Agreement (FFA) establishing a cleanup schedule for the base.

In accordance with Executive Order 12580 (Superfund Implementation) and the National Contingency Plan (NCP), the Air Force performed a Limited Field Investigation (LFI) for 20 Priority 2 Sites at Fairchild AFB. Twelve sites were determined to require no further action. The Air Force completed a Remedial Investigation/Feasibility Study (RI/FS) for the remaining eight sites which are designated Priority 2a Sites. The purpose of the RI/FS was to determine the nature and extent of contamination at these sites, to evaluate current and potential risks to human health and the environment posed by this contamination, and to evaluate various cleanup alternatives. The RI/FS addressed contamination associated with surface water, ground water, soil, and sediment.

The Air Force Installation Restoration Program (IRP) was initiated through the 1981 Executive Order 12316 that directed the military branches to design their own program of compliance with the NCP established by CERCLA. The IRP is designed to identify and assess potential contamination at past hazardous waste disposal and spill sites on Air Force installations and to remediate those sites when necessary.

A detailed discussion of the IRP including the history of the program, the program objectives, and the program organization is presented in the Fairchild AFB Priority 2a Sites Remedial Investigation/ Feasibility Study Work Plan (ICF 1993b).

1.1 SITE NAMES AND LOCATIONS

Fairchild AFB is located approximately 12 miles west of Spokane, Washington. Through June 1994, Fairchild AFB was home to the 92nd Bombardment Wing under the Air Combat Command. Since July 1994, Fairchild AFB has hosted the 92nd Air Refueling Wing under the Air Mobility Command. Fairchild AFB is also home to the 141st Air Refueling Wing of the Washington Air National Guard. Fairchild AFB occupies approximately 4,300 acres and contains one major runway with numerous taxiways. The base has approximately 1,600 housing units, an elementary school, a hospital, and numerous support facilities. Since 1942, various quantities of hazardous wastes have been generated and disposed of at Fairchild AFB. The sources of waste include fuel management, industrial and aircraft operations, and fire training activities.

The Air Force recently completed environmental investigations for 20 Priority 2 Sites at Fairchild AFB, Washington. The LFI concluded no further action was necessary at the following 12 of these sites:

- Site IS-2, Former Civil Engineering Warehouse;
- Site PS-3, Area C Pumphouse, Building 159;
- Site PS-4/PS-9, Pumphouse B, KC-135 Crash Site;
- Site SW-2, Waste Disposal Area Northeast of Wherry Housing;
- Site SW-3, Demolition Waste Disposal Area;
- Site SW-4, Former Coal Storage Area;
- Site SW-5, Former Incinerator at DRMO Yard;
- Site SW-7, Asphalt Waste Pile Area;
- Site SW-9, Radioactive Waste Disposal Area;
- Site SW-10, Disposal Area Near Jet Engine Test Stand;
- Site SW-12, Disposal Area East of Weapons Storage Area; and
- Site WW-2, Waste Water Treatment Plant.

The No Further Action Decision documents for the 12 no action sites and the Priority 2 Sites LFI report can be found in the administrative record file which is available for review.

Based on results of the LFI, the Air Force recommended an RI/FS for the remaining Priority 2 Sites (also referred to as Priority 2a Sites). An RI/FS was completed for the following eight Priority 2a Sites:

- Site IS-3, Reciprocating Engine Shop, Building 2150;
- Site IS-4, Jet Engine Test Stand, Building 3000;
- Site PS-1, Bulk Fuel Storage Area;
- Site PS-5, Fuel Oil Storage Tank at Wherry Housing;
- Site PS-7, Deep Creek Steam Plant, Building 1350;
- Site PS-10, Fuel Truck Maintenance Facility, Building 1060
- Site SW-11, Former Aircraft Reclamation Yard at Wherry Housing; and
- Site FT-2, Former Fire Training Area.

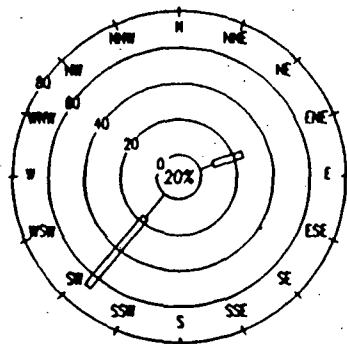
The location of the base and the eight Priority 2a Sites are shown in Figure 1-1.

DRAWING No. ROD-P2A4

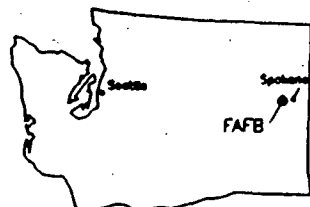
PS= Petroleum Site
 SW= Solid Waste Site
 IS= Industrial Site
 FT= Fire Training Site
 ☐= Surface Water Feature



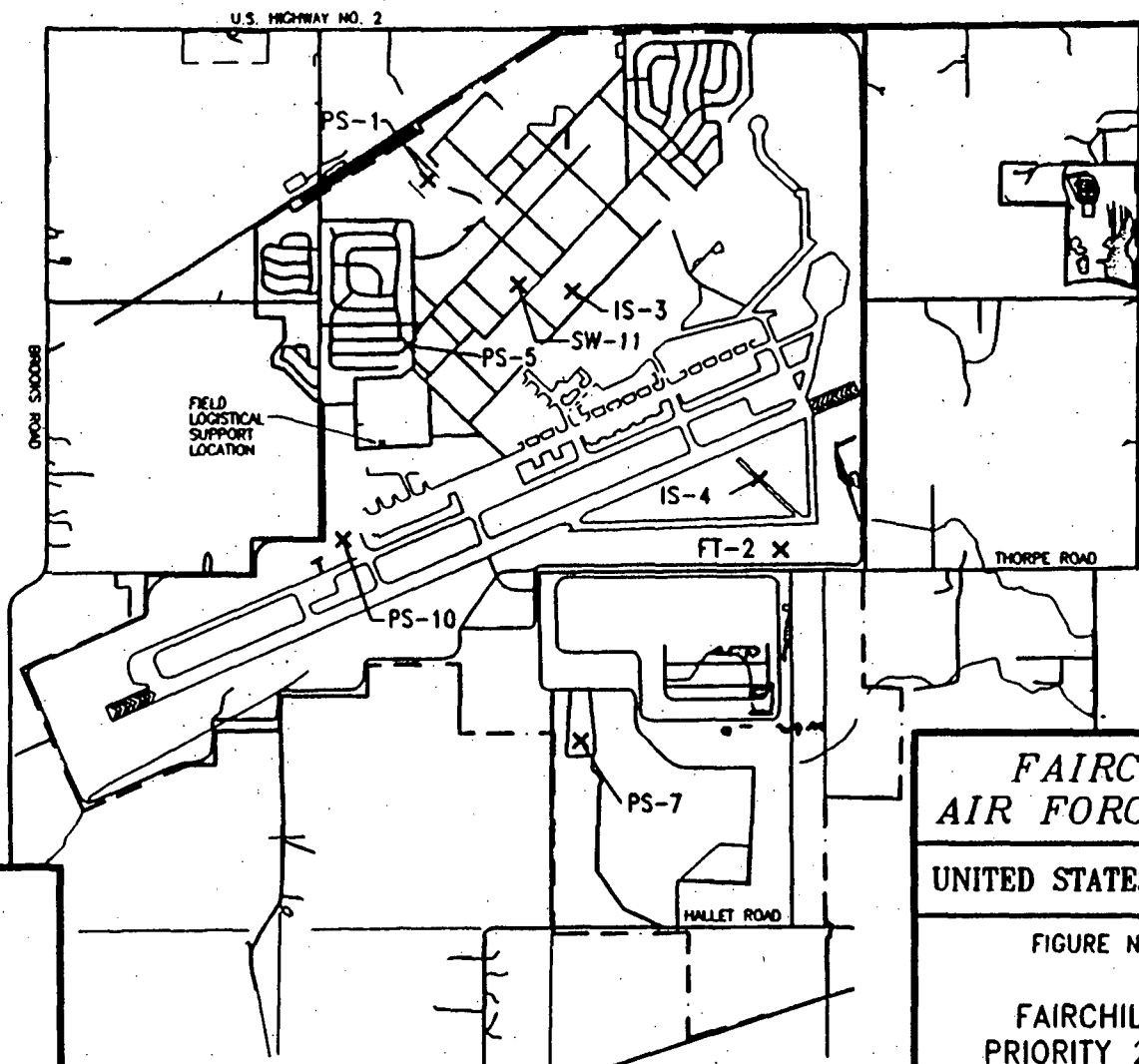
0 800 1600 3200
 SCALE IN FEET



1-5 6-10
 Miles per hour
 WIND ROSE



Key Plan



**FAIRCHILD
 AIR FORCE BASE**

UNITED STATES AIR FORCE

FIGURE NO. 1-1

**FAIRCHILD AFB
 PRIORITY 2A SITES**

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2.0 INSTALLATION ENVIRONMENTAL SETTING

The following bullets provide a general overview of the environmental setting at Fairchild AFB.

- **Contaminant Sources and Contamination.** Fairchild AFB has been in use since 1942. The Phase I IRP report categorized past activities of potential concern as management of petroleum, oils, and lubricants (POL), firefighter training, solid waste disposal, industrial shop activity, and waste water treatment (JRB Associates [JRB] 1985). A variety of contaminants, including petroleum residues, solvents, and metals, are present at the Priority 2a Sites.
- **Regional Topography.** Topographic relief at Fairchild AFB is approximately 100 feet. The maximum surface elevation is 2,470 feet above mean sea level at the west end of the main runway; the minimum elevation is 2,370 feet above mean sea level at the south boundary of the base.
- **Regional Geology.** Fairchild AFB overlies a series of Quaternary sediments which were deposited during and after the recession of flood waters from the Lake Missoula Floods. The sediments are primarily interbedded fine-grained sands and silts, with clays and gravels found locally. In several locations, loess deposits are interbedded with the alluvium. The Quaternary sediments are underlain by Tertiary basalts of the Columbia River Group. Basalt flows beneath Fairchild AFB occasionally breach the surface and are composed of the Wanampum and the Grande Ronde Formations. At most observed locations, the alluvial sediments are in gradational contact with the weathered flow top of the basalts.
- **Ground Water.** Ground water in the vicinity of Fairchild AFB occurs in the alluvial sediments and in fracture systems or interbeds in the basalt flows. Regional ground water flow across the base trends to the east-northeast. This trend coincides with a regional northeast trend in ground water flow toward the Spokane River. However, bedrock beneath the base is very irregular and creates local variations in ground water flow directions.

Ground water is typically encountered eight to 20 feet below the ground surface. In several locations, including IS-4, PS-1, and PS-10, the hydraulic connection between the alluvial and shallow bedrock aquifers is impeded by a low-permeability clay layer. Ground water flow within the bedrock is predominantly within the upper fractured portion of the upper basalt flow, or in the porous interbed at its base. Vertical ground water movement through the upper basalt flow is typically slow due to tightness or absence of fractures within the center of the basalt formation.

- **Surface Water.** Fairchild AFB is located in the south-central portion of the Deep Creek Watershed. This watershed drains approximately 120 square miles of Spokane and Lincoln Counties. Deep Creek flows to the east-northeast and

discharges to the Spokane River approximately 12 miles northeast of the base. The nearest naturally-occurring surface drainage to Fairchild AFB is a tributary of Deep Creek located along the southwest boundary of the base. No part of Fairchild AFB is located within any 100 year flood plain.

There are eight storm and waste water drainage systems at Fairchild AFB. Six systems of ditches, piping, and culverts discharge primarily storm water to various wetlands in the southern portion of the base, to the holding pond at the Conventional Weapons Storage Area, and off-base to the north, west, and south. The remaining two systems of open ditches and storm sewers convey storm water and waste water from industrial and base support activities to two on-base waste water lagoons. The larger lagoon (WW-1) discharges from the base through No Name Ditch and is regulated under the base's NPDES permit.

Air. Air quality at Fairchild AFB meets standards for all Clean Air Act criteria pollutants (particulates, sulfur oxides, nitrogen oxides, lead, ozone, and carbon monoxide). Inventory emission data for Spokane County for 1987 indicate releases from Fairchild AFB accounted for approximately 0.3% of the county particulate emissions and 1.1% of the carbon monoxide emissions. Air releases from Priority 2a Sites are discussed in the Remedial Investigation Report (ICF 1995a).

- **Biology.** Fairchild AFB is located where the open, semi-arid grassland habitat of the Columbia Basin changes to the Ponderosa pine habitat of the Okanogan Highlands. The southern portion of the base is relatively undisturbed and is dominated by native bunch grasses. The disturbed and developed portions of the base to the north (e.g., the runway, flightline, and industrial/administrative areas) are dominated by turf grass and ornamental trees in the northern edges/extent of the base. A mixture of native and non-native grasses dominate the central portion of the base. Few trees and shrubs are found on the base.

Wetlands east of the weapon storage area are dominated by grasses, sedges, and Russian-olive trees at different stages of maturity. The wetlands are home to a variety of water fowl, dominated by mallard ducks. They feed primarily on aquatic plants and insects. Upland birds such as ring-necked pheasants and gray partridges reside in adjacent grasslands feeding on plants, seeds, and insects. Several raptor species, including red-tailed hawks, marsh hawks, and American kestrels, are in many areas of the base preying on numerous species of birds and small mammals.

The mammals observed on the base are white-tailed deer, Columbian ground squirrels, coyotes, and badgers. Of these, the white-tailed deer and Columbian ground squirrels are primarily herbivores, feeding on grasses and leaves of trees and shrubs. The ground squirrels also eat seeds and insects. Badgers are primarily carnivores, feeding on small mammals and birds. The coyote is an omnivore, feeding on fruits and other plant parts and small animals.

No federal or state threatened or endangered species or critical habitats are known to be associated with Fairchild AFB.

- **Demographics.** On-base workers and residents are a significant local population. Approximately 8,500 military personnel and civilians reside and/or are employed on the base. There are 1,580 family housing units and 661 dormitory units on the base; approximately 5,300 military personnel and dependents reside on-base. Housing areas are located in the north-central and northeast portions of the base.

The nearest community is Airway Heights, located approximately 2 miles northeast of Fairchild AFB. Airway Heights has a population of approximately 2,100. The community of Medical Lake is located approximately 3 miles south-southwest of the base and has a population of approximately 3,700. Rural residences outside Fairchild AFB include trailer parks north and east of the base and scattered residences to the east and south. The total population of residents living within a one-half mile radius of Fairchild AFB is estimated to be less than 1,000.

Land use in the vicinity of Fairchild AFB is primarily agricultural, industrial, commercial, and residential. Agricultural use includes both non-irrigated and irrigated cultivation of small grains and hay, and cattle grazing. Land on the base is both developed and undeveloped. Undeveloped land includes mixed grasses and shrubs and some wetlands.

- **Climate.** The climate at Fairchild AFB is semi-arid with warm, dry summers and cold, damp winters. The average annual precipitation at Fairchild AFB is 15.7 inches (ICF 1995a). Approximately 70% of the annual precipitation falls between the first of October and the end of March; greater than 50% falls as snow. The growing season in the Spokane region usually extends from mid-April to mid-October with irrigation required for all crops except dryland grains. Winter weather includes many foggy and cloudy days, below freezing temperatures, and occasional snowfall several inches in depth. Sub-zero temperatures are uncommon. The National Oceanic and Atmospheric Administration reports the average annual evapotranspiration for Spokane County is 12.8 inches per year (JRB 1985).

Between January 1988 and December 1993 the mean annual temperature was 47.3°F. The highest temperature recorded during this six year period was 99° F on 13 and 14 August 1992. The lowest temperature observed was -16° F on 29 December 1990.

Most of the year, the prevailing wind direction at Fairchild AFB is from the southwest, with an average annual wind speed of 6 to 10 miles per hour. However, during the winter months the prevailing wind direction is east-northeast. Calm conditions occur approximately 20% of the year (Air Force 1990). The wind rose provided in Figure 1-1 shows the average wind speed and direction based on data from October 1979 to September 1989.

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3.0 PREVIOUS INSTALLATION RESTORATION PROGRAM INVESTIGATIONS AT FAIRCHILD AIR FORCE BASE

JRB, an Air Force contractor, conducted Phase I Installation Assessment/Record Search activities at Fairchild AFB in 1984. Phase I activities included a records search, personnel interviews, site inspections, and follow-on recommendations. The objective of Phase I was to identify and assess sites that might pose a problem due to past hazardous waste or substance disposal or spills. The Phase I identified a total of 22 potential sites, 12 of which were recommended for further investigation under Phase II (JRB 1985).

The Air Force began Phase II, Stage 1, Confirmation/Quantification studies in 1986 through a contract with Battelle Memorial Institute, Denver Operations (Battelle). Battelle prepared a Technical Operations Plan for the Phase II work in 1986 (Battelle 1986). Phase II, Stage 1 activities involved extensive data collection activities, including sampling and analysis of potentially contaminated ground water and soils. Results of the Phase II, Stage 1, activities are documented in the Phase II, Stage 1 report (Battelle 1989).

The results of the Phase II, Stage 1 activities provided a basis for recommendations for Phase II, Stage 2, Confirmation/Quantification studies to further characterize sites. Stage 2 activities began in September 1988 with development of a Work Plan (Battelle 1988); field activities were completed in March 1990.

In 1990, while the Stage 2 work was ongoing, Fairchild AFB entered into a FFA under CERCLA Section 120 with the EPA and the Ecology. This agreement divided the existing sites under investigation at Fairchild AFB into Operable Units which included Priority 1 Sites, and Potential Operable Units which included Priority 2 Sites. The FFA specified a schedule for conducting RI/FS activities for the Priority 1 Sites and identified procedures for determining the disposition of the Priority 2 Sites. Through a contract with Science Applications International Company (SAIC), the Air Force published the results of the Stage 1 and Stage 2 investigations for the Priority 1 Sites (SAIC 1990a), and Priority 2 Sites (SAIC 1990b). The Air Force completed RI/FS activities at the Priority 1 Sites with the signing of the ROD for Craig Road Landfill in February 1993 and the signing of the ROD for the On-Base Priority 1 Sites in July 1993.

In 1991, the Air Force, EPA, and Ecology determined additional characterization of the Priority 2 Sites was needed to better scope the RI/FS activities for these sites. Through a contract with ICF Technology Incorporated, the Air Force performed LFIs for these sites in 1991 and 1992. Based on results of the LFIs, the Air Force recommended an RI/FS for eight Priority 2 Sites discussed in this document.

The results of previous IRP investigations at Fairchild AFB include numerous work plans, informal technical information reports, and investigation and study reports. Records of Decisions (RODs) have been prepared and approved for all Priority 1 Sites. These sites are currently in the remedial design, remedial action, long-term monitoring, and/or long term operational phases of the remedial activity. All project documents are contained in the Fairchild AFB administrative record and are available for review.

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4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Air Force developed a Community Relations Plan (CRP) in March 1990 as part of the overall management plan for environmental restoration activities at the base. The CRP was designed to promote public awareness of the investigations and public involvement in the decision-making process. The CRP summarizes concerns that Fairchild AFB, in coordination with EPA and Ecology, are aware of based on community interviews and comments obtained at a public workshop. Since this initial workshop, Fairchild AFB has sent out numerous fact sheets and has held annual workshops and/or public meetings in an effort to keep the public informed and to hear community concerns.

The Remedial Investigation Report for the on-base Priority 2a Sites (ICF 1995a) was released to the public on February 3, 1995, the Feasibility Study (ICF 1995b) and Proposed Plan (ICF 1995c) were released on May 2, 1995. The Proposed Plan was mailed to each address on the mailing list. These documents, as well as previous reports from the RI/FS investigation, were made available to the public in both the Administrative Record and the Information Repository maintained at the locations listed below:

- ADMINISTRATIVE RECORD (contains all project deliverables):

Spokane Falls Community College Library
West 3410 Fort George Wright Drive
Spokane, WA 99204
(509) 533-3800

- INFORMATION REPOSITORY (contains limited documentation):

Airway Heights City Hall
South 1208 Lundstrom
Airway Heights, WA 99101
(509) 244-5578
Business Hours are: Monday through Friday, 8:00 a.m. - 5:00 p.m.

The notice of the availability of these documents was published in *The Spokesman Review* on April 30, 1995. The public comment period was held from May 2, 1995 to May 31, 1995. In addition, a public meeting was held on May 10, 1995. Prior to this meeting, copies of the Proposed Plan were sent to over 200 local residents and other interested parties. At this meeting, representatives from the Air Force, EPA, and Ecology answered questions about problems at the Priority 2a Sites and the remedial alternatives under consideration. A response to the comments received during the public comment period is included in the Responsiveness Summary, which is part of this ROD (Appendix B). This ROD is based on the Administrative Record.

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5.0 SCOPE AND ROLE OF OPERABLE UNITS

Potential source areas at Fairchild AFB have been grouped into separate operable units. A different schedule has been established for each of the operable units. The Craig Road Landfill (CRL) site comprises the first Priority 1 Operable Units (OU-1) at Fairchild AFB. A ROD was signed in February of 1993 for the CRL site and a cleanup action is in progress. The second Priority 1 Operable Units (OU-2) consisted of five soil and ground water contamination sites. A ROD was signed in July of 1993 for the OU-2 sites. Selection of cleanup actions for Priority 2 Operable Units (OU-3) is being made in this ROD. The cleanup actions described in this ROD address select onsite ground water contamination and source areas associated with surface and subsurface contamination at the sites. In doing so, the cleanup actions described in this ROD address current and potential risks to human health and the environment associated with the on-base Priority 2a Sites.

The Priority 3 Operable Units are in the Site Inspection phase at this time. Ground water contamination at IS-4 and PS-10 will be investigated as part of the Priority 3 Operable Units. A ROD for the Priority 3 Operable Units may be signed as early as 1999.

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6.0 SITE INVESTIGATION RESULTS

Since 1993, environmental samples (i.e., soil-gas, soil, sediment, surface water, and ground water samples) have been collected at the Priority 2a Sites during five separate sampling events. The following is a brief discussion of activities conducted.

- **March-April 1993**--Activities included the installation of all soil borings and ground water monitoring wells at PS-1, PS-5, PS-7, PS-10, and FT-2. A soil-gas survey was conducted at PS-1 to assess the extent of subsurface fuel contamination. A geophysical survey was conducted at PS-5 to assess the extent of phase-separated hydrocarbons observed during the LFI removal action. A sump assessment, including the collection of sediment and water samples was completed at IS-3. A sump assessment was performed at PS-7 to evaluate hydraulic characteristics of the shallow aquifer at the site. The field staff collected (excluding QA/QC samples) 161 soil/sediment, 24 water, and 187 soil gas samples.
- **July 1993**--Activities included the installation of ground water monitoring wells and the removal of petroleum contaminated soil at IS-4. Additional soil samples were collected at SW-11 to assess metals contamination in shallow soil. The second quarterly ground water sampling was also conducted. The field staff collected (excluding QA/QC samples) 27 soil and 31 water samples.
- **October 1993**--Activities included completion of soil borings as part of the corrective action (see Section 2.2.3.8) and the third quarterly ground water sampling. The field staff collected (excluding QA/QC samples) 57 soil and 36 water samples.
- **January 1994**--Activities included the fourth and final round of quarterly ground water sampling. The field staff collected (excluding QA/QC samples) 34 water samples.
- **March 1994**--Activities (principally the collection of surface soil samples at PS-10 to determine concentrations of volatile organic compounds [VOC] and petroleum) had decreased because of volatilization or natural degradation. The field staff collected (excluding QA/QC samples) 3 soil samples.

Samples collected during these activities were sent for laboratory analyses. Results were evaluated to determine nature and extent of contamination, and to perform human health and ecological risk assessments.

Basewide natural background levels for metals in soil were determined using 30 soil samples from uncontaminated sites at Fairchild AFB. The data were fitted to either a normal or lognormal distribution per Ecology guidance (Ecology 1992). The natural background level was assumed to be the 95% upper tolerance limit for the 90th percentile of the data. For non-detection data,

half the detection limit was substituted for the raw data. Outliers more than four standard deviations from the mean were excluded from the data set. Site specific natural background levels were also determined at PS-1, SW-11, and FT-2 using a smaller number of samples collected near the sites. Basewide natural background levels for dissolved and total metals in ground water were determined using 21 ground water samples. Methodology for calculating ground water natural background levels was the same as for soil.

The maximum concentrations of chemicals detected during the LFI and RI at the Priority 2a Sites were compared to screening levels to determine which chemicals would be evaluated in the risk assessment (see Appendix A). The screening levels were Washington State MTCA Method B cleanup levels, chemical-specific Risk Based Screening Levels (RBSLs), and, where appropriate, natural background levels. RBSLs used to select the chemicals of concern, were based on the residential exposure scenarios described in Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B: Development of Risk-based Preliminary Remediation Goals. This is a more conservative approach than basing the RBSLs on a commercial/industrial scenario. Maximum Contaminant Levels (MCLs) were also used to screen ground water contaminants of concern. Chemicals measured at concentrations that exceeded a Method B cleanup level or an RBSL and the natural background levels (if available) were retained as potential contaminants of concern. Chemicals that did not have Method B cleanup levels, RBSLs, or natural background levels were also retained as potential contaminants of concern. The potential for health effects associated with exposure to such chemicals cannot, however, be quantified because their toxicity has not been determined. Exposure to such chemicals is not necessarily without risk or hazard, the risk or hazard simply cannot be quantified.

Cancer risk assessments and noncancer hazard assessments are used to estimate current and future risk if a site is not cleaned up. As part of the remedial investigation, the Air Force prepared a risk and hazard assessment for each site to evaluate potential human health and environmental risks resulting from exposure to site contamination.

The human health risk assessment for the Priority 2a sites estimated the potential for contracting cancer or other adverse health effects from residential and Air Force Personnel/Contractor (industrial) exposure scenarios to site contamination. Standard EPA default exposure assumptions were used to characterize human health risk for a residential scenario and for an Air Force Personnel/Contractor (industrial) scenario. The exposure assumptions for these scenarios are described in EPA Region 10: Supplemental Risk Assessment Guidance for Superfund (August 16, 1991). Calculation of the excess lifetime cancer risk and the noncancer hazard for each Priority 2a site was based on the 95th percentile upper confidence limit on the arithmetic mean concentration for the Reasonable Maximum Exposure (RME) scenario, and on the arithmetic mean for the average case scenario. This assessment uses reasonable conservative assumptions to determine risk, such as daily exposure to contamination for 30 years. The risk assessment also considers changes in uses of land or ground water that may occur in the future. The range of acceptable risk for carcinogens, as stated in the NCP, is one additional chance in one million (1×10^{-6}) to one additional chance in ten thousand (1×10^{-4}). The hazard assessment estimates risk for exposure to non-carcinogens. For non-carcinogens,

acceptable levels are generally those to which the human population may be exposed throughout a 30 year period without adverse health effects. Non-carcinogenic risks are estimated by calculating a Hazard Quotient (HQ). According to both federal and state hazardous waste laws, an acceptable risk level for non-carcinogens is a HQ value less than 1.0.

Several sources of uncertainty affect the estimates of excess lifetime cancer risk and noncancer hazard as presented in the risk assessment. The sources are generally associated with:

- Sampling and analysis of soil and ground water;
- Assigning the source of contamination;
- Exposure assumptions, including estimates of exposure point concentrations;
- Evaluation of the toxicity of the contaminants of concern; and
- Methods and assumptions used to characterize the cancer risk and noncancer hazard.

Uncertainties associated with sampling and analysis include the inherent variability (standard error) in the analysis, representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. While the quality assurance/quality control program used in conducting the sampling and analysis serves to reduce errors, it can not eliminate all errors associated with sampling and analysis.

Simplifying assumptions were made about the environmental fate and transport of the site contamination, specifically, no contaminant loss or transformation has or will occur. Thus, the estimation of exposure point concentrations in the risk calculations is an additional source of potential error.

The estimation of exposure requires many assumptions to describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, frequency of contact with contaminated media, the concentration of contaminants at exposure points, and the time period of exposure. These then to simplify and approximate actual site conditions. In general, these assumptions are intended to be conservative and yield an overestimate of the true risk or hazard.

The toxicological database is also a source of uncertainty. The EPA has outlined some of the sources of uncertainty in Guidelines for Carcinogen Risk Assessment, Guidelines for the Health Risk Assessment of Chemical Mixtures, and Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final. These sources include extrapolation from high to low doses and from animals to humans; species, gender, age, and strain differences in uptake, metabolism, organ distribution, and target site susceptibility; and human population variability with respect to diet, environment, activity patterns, and cultural factors.

In the risk characterization, the assumption was made that the total risk of developing cancer from exposure to site contaminants is the sum of the risk attributed to each individual contaminant. Likewise, the potential for the development of noncancer adverse effects is the sum of the hazard quotients estimated for exposure to each individual contaminant. This approach does not account for the possibility that chemicals act synergistically or antagonistically.

An ecological risk assessment was conducted to evaluate the potential adverse impacts to plants and animals resulting from exposure to contamination associated with the Priority 2a Sites. The assessment investigated potential impacts to burrowing and ground-dwelling animals exposed to surface and sub-surface soil contamination at the sites as well as impacts to wildlife exposed to contaminated surface water and sediments.

The following paragraphs summarize remedial investigation activities and the results of the risk assessment at the Priority 2a Sites. Tables of analytical results and risk calculations are presented in Appendix A. Site locations are shown in Figure 1-1.

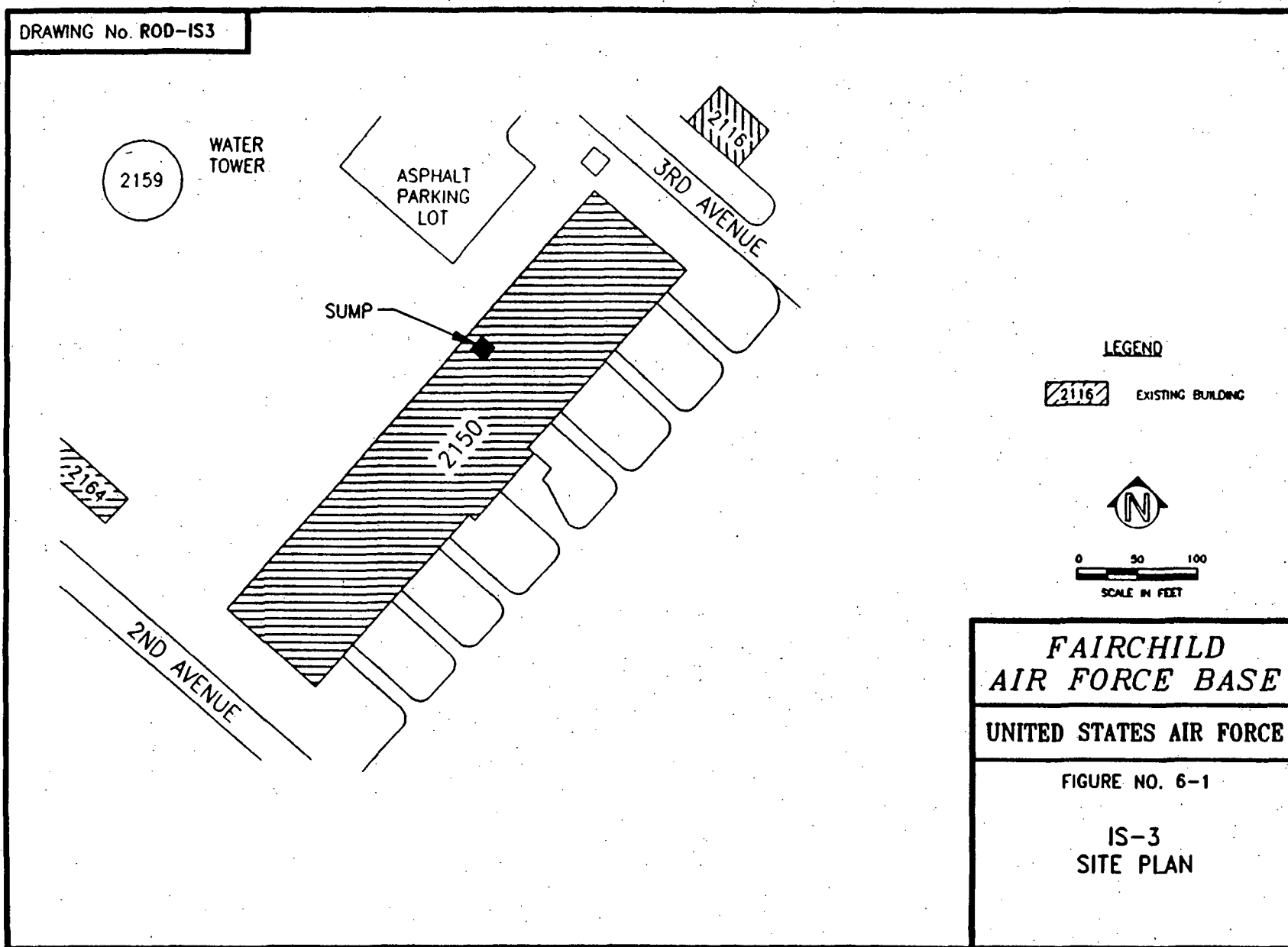
6.1 IS-3, RECIPROCATING ENGINE SHOP, BUILDING 2150

IS-3 consists of Building 2150, the former reciprocating engine test facility, located in the upper central portion of Fairchild AFB near Arnold Street between 2nd Avenue and 3rd Avenue. A site plan is shown in Figure 6-1. The area of concern at IS-3 is a sump located in the basement of Building 2150.

6.1.1 Background

Building 2150 was constructed in 1942 as part of the initial base construction. The structure was specifically designed and built as a radial engine test facility and was used from 1942 until approximately 1956 to test gasoline-powered reciprocating aircraft engines. Since 1956, Building 2150 has been used for several purposes including entertainment, a communications center, and for incineration of classified documents in Test Cell 3. More recently, the Air Force used the building as a temporary storage area for polychlorinated biphenyl (PCB) laden transformers during basewide PCB removal. Six large PCB-containing transformers originally installed in the building were removed at that time. The transformers were stored in steel pans to contain any spills or fluid leaks. A contractor completed removal of the PCB materials stored in the building in 1991. Currently Building 2150 is locked and not in use.

During a site inspection, a red, oily liquid, probably aircraft engine lubricating oil, was observed on the floor at several locations in the basement. Several small steel drums were found containing red, oily liquid. An 8.5 foot deep sump is located in the basement. Automatic pumps installed in the sump had lifted sump water from the basement level into a storm sewer line outside the building on the north side. The sump contained water during the investigation. The source of the water was apparently floor drainage from connected floor drains although this could not be conclusively proven. There was no evidence to suggest leakage from the sump to ground water had occurred.



Previous IRP investigations reported one PCB (Aroclor-1260) in three samples collected from pooled oil on the basement floor ranging in concentration from 8.8 mg/kg to 44.0 mg/kg. PCBs were not detected in oil collected from the steel drums.

6.1.2 Nature and Extent of Contamination

The remedial investigation focused on an assessment of the sump in Building 2150 as a possible contaminant release point and its contents as a possible contamination source. All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations.

6.1.2.1 Sump Assessment. No conclusions could be drawn from a review of Building 2150 engineering drawings as to whether a connection exists between floor drains and the sump. The source of the water in the sump is unknown, but may be due to roof leakage and condensation. After pumping about one third of the liquid from the sump, exposed portions of the sump walls were inspected for integrity. No breaches were visible. Basewide ground water maps show ground water near Building 2150 at approximately 5 to 8 feet below the sump water level. This difference instead indicates there is not a large leak from the sump to ground water and ground water could not infiltrate into the sump. There is not sufficient data, however, to determine if sump water infiltrates to ground water through a very small leak or leaks intermittently.

6.1.2.2 Sump Sediments. Analyses of the sump sediments detected concentrations of fuel-related VOC, metals, and PCB. P-cymene, 1,4-dichlorobenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, toluene, ethylbenzene, and total xylenes were reported in the sump sediment at concentrations below screening levels.

Metals detected above natural background levels included antimony, cadmium, chromium, lead, and mercury. PCB (Aroclor-1254) was detected in the sump sediment at a maximum concentration of 0.31 mg/kg.

6.1.2.3 Sump Water. Water removed from the sump contained VOC, SVOC, metals, and PCB. The VOC detected were toluene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene. The only SVOC detected in the samples collected was bis(2-ethylhexyl)phthalate. This compound is commonly found in environmental samples and has been documented as an artifact of sample handling or laboratory methods. Metals analyses for sump water showed concentrations of lead and zinc above the high normal ground water background levels. PCB as Aroclor-1242 was detected at a concentration of 0.21 µg/L, which is below the PCB MCL of 0.5 µg/L.

6.1.3 Summary of Site Risks

For the purpose of completing risk characterization, the Air Force assumed the sump leaks at appreciable rates to the surrounding soil and ground water. Based on this scenario, residential exposure to ground water was evaluated. Air Force personnel and contractors are the only receptor populations likely to become exposed to the contamination inside Building 2150. Therefore, the risk assessment focused on quantifying the risk to this receptor group from direct exposure to water and sediments in the sump.

6.1.3.1 Contaminants of Concern. Six chemicals observed in the sump sediment were identified as potential contaminants of concern: lead, p-cymene, bis(2-ethylhexyl)phthalate, PCB-1254, and 1,2,4- and 1,3,5-trimethylbenzene. However, because of limited toxicity reference data, health risks or hazards could not be quantified for lead, p-cymene, or the trimethylbenzenes. PCB-1254 and bis(2-ethylhexyl)phthalate exceeded a risk screening level based on carcinogenicity and were retained as contaminants of concern in sump sediments. Health risks and hazards were evaluated for these two compounds.

The concentrations of lead and PCB-1242 in the sump water exceeded a risk screening level concentration. The risk of health effects associated with exposure to lead cannot be quantified, however, because EPA has not provided a reference dose or a slope factor with which to quantify risk. The Air Force estimated the risk associated with exposure to PCB-1242 by the drinking water ingestion pathway.

6.1.3.2 Human Health Risk Assessment. For site IS-3, current risk under the Air Force Personnel/Contractor scenario is principally due to direct exposure to PCB-1254 in sump sediments and ingestion of PCB-1242 in sump water. The risk associated with exposure to PCB-1254 in sump sediments is 4×10^{-7} and the risk associated with ingestion of sump water containing PCB-1242 is 2×10^{-6} . The cumulative risk for exposure to sump sediments and water is 2×10^{-6} , which is within the acceptable range. The current hazard associated with exposure to sump sediments under the same scenario is principally due to exposure to bis(2-ethylhexyl)phthalate. That hazard is 0.0002, which is below the screening threshold of 1.0. The hazard associated with exposure to sump water is not quantifiable because the EPA has not published a reference dose for oral exposures to PCBs. All risks and hazards calculated for Site IS-3 are based on RME assumptions. If contaminants leaked to the subsurface soil or ground water they would be diluted and the associated risk and hazard would be reduced.

6.1.3.3 Ecological Risk Assessment. There is no indication site conditions are impacting the wildlife or plant communities. There is no apparent ecological risk to target species at IS-3.

6.1.4 Conclusions

An assessment of the integrity of the sump indicated the possibility of a large leak of contaminated sump water to ground water is extremely small, but the possibility of a small leak does exist.

The building is presently unoccupied and locked. Institutional controls limit access to contractors or Air Force personnel conducting site investigations, so the potential for direct contact with the sump water and sediments by on-base residents and the general public is virtually non-existent. The Air Force recommends draining the sump completely to visually inspect the integrity of the sump walls and to determine if sump water is or has been in communication with ground water. The Air Force is also reviewing plans to demolish this building, at which time soils surrounding the sump will be sampled and analyzed for PCB contamination. If cleanup levels are exceeded, contaminated soils will be removed and disposed of in accordance with all applicable federal, state, and local regulations.

6.2 SITE IS-4, JET ENGINE TEST STAND, BUILDING 3000

Site IS-4 is a former jet engine testing facility located south of the east end of the instrument runway in the central eastern portion of the base. The site is inactive and all structures have been razed. Currently, the site consists of former engine test cells, a storm water ditch that trends to the east-northeast immediately north of the test stand, and a large rubble pile that served as a blast shield during testing activities. A site map is presented as Figure 6-2.

6.2.1 Background

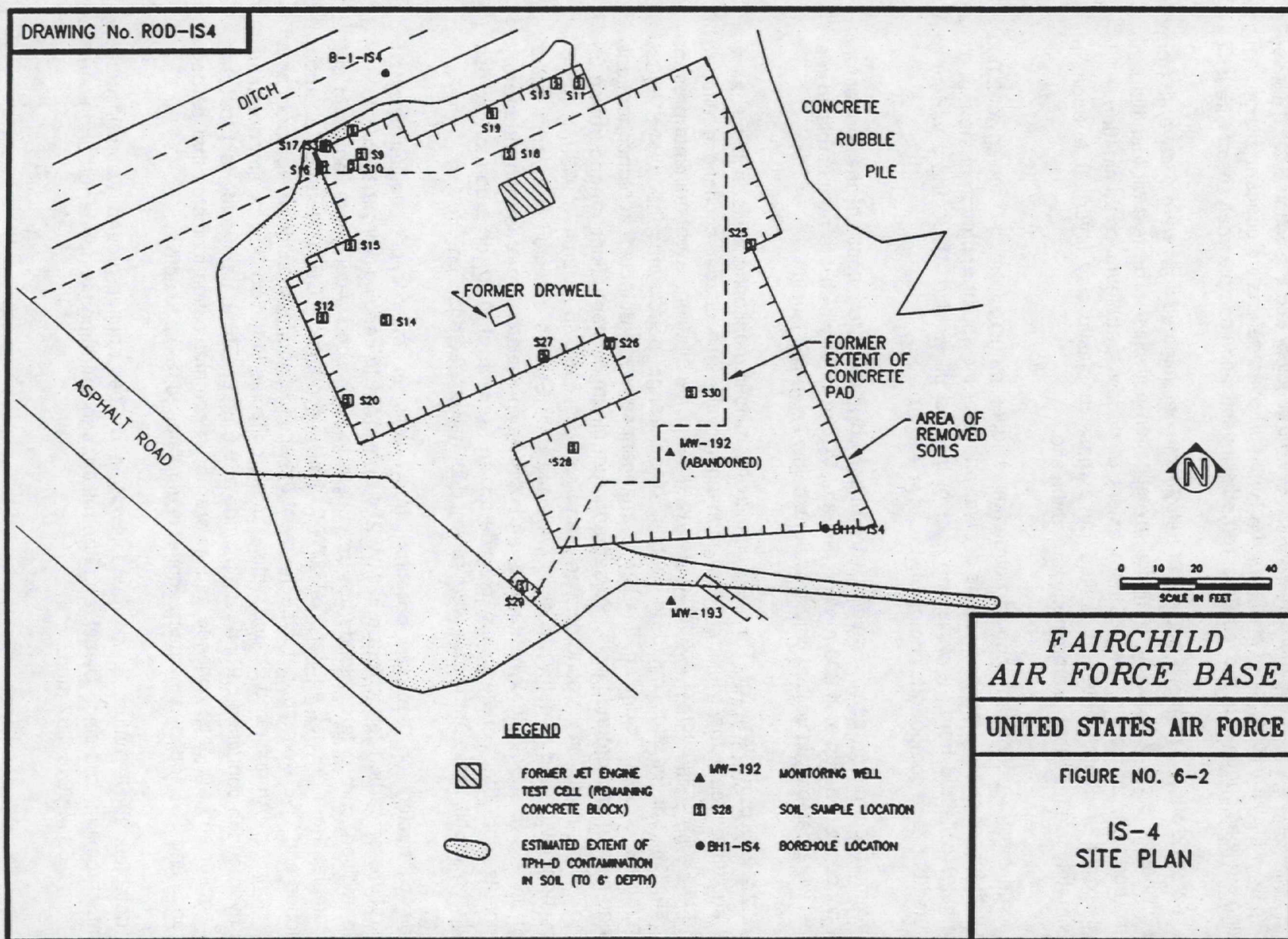
From 1953 to 1989, IS-4 was used for jet engine testing activities. Engine testing operations prior to 1979 resulted in uncontrolled releases of jet fuel to the fuel stand surface, a dry well, and an oil water separator. After 1979, the Air Force reportedly used spill control procedures to contain fuel releases and no longer used the dry well.

Site investigations detected the presence of fuel residues in soils adjacent to the oil-water separator. Petroleum was detected at concentrations up to 3,979 mg/kg in soils adjacent to the dry well and up to 1,947 mg/kg in soils adjacent to the southern test cell. Toluene, xylene, ethylbenzene, naphthalene, methylnaphthalene, and bis(2-ethylhexyl)phthalate were also observed in soil samples. Ground water sampling yielded diesel range petroleum at a maximum concentration of 3.0 mg/L from MW-192 in November 1992, and showed BTEX concentrations in all samples collected from this well.

In July 1993, 1,060 yd³ of petroleum-contaminated soil was excavated from the site and transported to a thermal desorption facility for treatment.

6.2.2 Nature and Extent of Contamination

Field activities included excavating a test pit, collecting surface soil samples, installing and sampling soil borings, and installing and sampling shallow monitoring wells. Approximately 1,800 yd³ of diesel range petroleum contaminated soil remains at the site (see Figure 6-2). All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared



to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations. The following sections summarize the results of remedial investigation sample analyses at Site IS-4.

6.2.2.1 Soils. A total of 1,060 yd³ of petroleum-contaminated soils were excavated from a test pit near the dry well during remedial investigation activities. The test pit identified the eastern, northern, and partly the southern extent of vadose petroleum contamination. The vertical extent of contamination is limited by a massive plastic clay layer, at a depth of approximately five feet, that is prominent across the site.

Field screening for petroleum showed petroleum residues ranging from 10 mg/kg to 2,000 mg/kg with higher concentrations near the dry well and near the southern portion of the test pit. Soil samples collected from the walls and floor of the test pit yielded BTEX and a variety of substituted benzene compounds commonly found in jet fuel.

The maximum petroleum concentrations were observed immediately south of the former dry well at concentrations up to 4,800 mg/kg. Several VOCs, all of which are attributable to fuel releases, were detected in soils at concentrations below screening levels.

6.2.2.2 Ground Water. The Air Force installed four monitoring wells in the shallow alluvial aquifer beneath the site and three monitoring wells in a deeper confined aquifer to assess the vertical migration of observed ground water contamination. Contaminants present in the shallow aquifer are limited to metals, diesel range petroleum, and two SVOCs. Concentrations of zinc, cadmium, lead, and manganese were detected at concentrations exceeding natural background levels. Diesel range petroleum concentrations ranged from 0.05 mg/L to 0.87 mg/L in ground water samples collected in March 1993. Bis(2-ethylhexyl)phthalate and dimethylphthalate were the only SVOCs detected in ground water beneath IS-4. Bis(2-ethylhexyl)phthalate and dimethylphthalate are common laboratory contaminants and their presence is considered an artifact of field or laboratory cross contamination. Still, these phthalates were retained for risk characterization.

Analyses conducted on samples collected from wells in the deeper aquifer yielded concentrations of carbon tetrachloride in MW-214 and MW-216 ranging from 2.1 µg/L to 4.5 µg/L. In addition, carbon tetrachloride has been detected in ground water upgradient from the site. Samples from deeper aquifer Well MW-214 also contained TCE at 1 µg/L. Carbon tetrachloride and TCE were not detected in any of the shallow aquifer monitor wells, nor in any site soil samples. An unfiltered ground water sample collected in the shallow confined aquifer using a hydropunch contained carbon tetrachloride at 6.6 µg/L. This data and the fact that the shallow aquifer and the deep confined aquifer are not in communication indicates that carbon tetrachloride and TCE found in the deep aquifer is unrelated to IS-4 site activity.

Metals detected above natural background levels in deeper aquifer ground water include cadmium, chromium, and zinc. Diesel range petroleum concentrations in deeper ground water ranged from 0.53 mg/L to 0.87 mg/L.

6.2.2.3 Ditch Surface Soil and Surface Water. Soil and water samples collected from the storm water ditch located immediately north of IS-4 were used to assess possible interaction between surface water in the ditch and ground water in the vicinity of IS-4.

Results of the ditch sampling show the presence of methylene chloride and metals including cobalt, copper, manganese, and nickel in ditch bank sediments. Methylene chloride is a common laboratory contaminant. Metals detected in ditch surface water include arsenic, silver, manganese, lead, and zinc. However, there is no correlation between contaminants detected in the ditch and those detected in soil or ground water at IS-4.

6.2.3 Summary of Site Risks

Potential receptors to environmental contamination at IS-4 are Air Force personnel and contractors conducting activities at the site. Because the site is within one quarter of a mile of the flightline and access to the area is monitored, only Air Force personnel and contractors have access to the site. Given the remote location and the limited access, the Air Force concludes there is no realistic exposure scenario for current base residents, visitors, or trespassers. However, exposures for hypothetical future residents to current concentrations were evaluated.

Current exposure pathways at IS-4 are limited to ingestion or direct dermal contact with surface water and contaminated soil. The analytical data for soils at IS-4 indicates VOC in soil are present at concentrations well below their risk screening levels. Therefore, volatilization of chemicals in the soil will be in only trace amounts and subsequent inhalation exposure is not considered a complete exposure pathway.

6.2.3.1 Contaminants of Concern. Five metals and seven organic compounds were retained as potential contaminants of concern for the risk assessment of IS-4 ground water. The metals included arsenic, cadmium, chromium, lead, and manganese. The organic compounds included benzene, carbon tetrachloride, bis(2-ethylhexyl)phthalate, ethylbenzene, toluene, total xylenes, and 2-methylnaphthalene.

Based on the maximum concentrations measured in soil, two metals and four organic compounds were retained as potential contaminants of concern for the risk assessment of exposures to IS-4 soils. The metals were cobalt and manganese. The organic compounds detected in soil are presumed to be fuel components including sec-butylbenzene, n-propylbenzene, and 1,2,4- and 1,3,5-trimethylbenzene. Risk or hazard assessments were not calculated on these four organics or on cobalt because there is no reference toxicity data for these compounds.

Based on the maximum concentrations measured in surface water, three metals were retained as potential contaminants of concern for the risk assessment of IS-4 surface water. These are arsenic, chromium, and manganese.

6.2.3.2 Human Health Risk Assessment. For site IS-4, current risk, based on RME assumptions, under the Air Force Personnel/Contractor scenario is principally due to ingestion of arsenic contaminated ground water and rounds up to 3×10^{-4} . Hazard associated with exposure to site ground water under the same scenario is 8 which is principally due to ingestion of

manganese. The ground water exposure pathway is incomplete and may never exist given the adequacy of the base water supply system. Ground water contamination will be addressed under the Priority 3 Operable Unit. Hazard associated with exposure to site soil under the same scenario is 0.4 and is due to ingestion of manganese and petroleum. The soil exposure hazard is at an acceptable level. These values do not include risk or hazard related to site surface water because contamination in surface water is not related to this site. It was, nevertheless, evaluated in the RI and is presented in the tables in Appendix A, raising the cumulative risk to 4×10^{-6} , and cumulative hazard to 9. Risk associated with exposure to petroleum contaminated soil can not be quantified.

6.2.3.3 Ecological Risk Assessment. The ecological risk to target species visiting the site and the nearby ditch does not exceed acceptable levels. The ecological quotients for the contaminants of concern are at least two orders of magnitude less than one.

6.2.4 Conclusions

Ground water contamination at IS-4 is not attributable to site activities. Ground water contamination at this site will be addressed as part of the Priority 3 Operable Unit. Because of this, cleanup alternatives were not evaluated for ground water.

There is no unacceptable risk or hazard associated with exposure to soil at IS-4. Petroleum contamination in soils still present at the site exceeds Washington State cleanup levels. Also, petroleum in soil could serve as a source for ground water contamination. For these reasons, soil cleanup alternatives were evaluated.

6.3 SITE PS-1, BULK FUEL STORAGE AREA

PS-1 is the main bulk fuel storage facility at Fairchild AFB. Figure 1 -1 shows its location. The site consists of four above ground fuel tanks, and their asphalt covered, bermed containment areas. The four above ground tanks store approximately three million gallons of JP-4.

6.3.1 Background

PS-1 has been in operation for approximately 40 years. The four tanks, 2400, 2405, 2406, and 2410, were built between 1952 and 1960. Most fuel moves to and from the tank farm via underground pipes. Delivery outlets are located along the rail siding and at the fuel truck loading station on the southwest boundary. When the underground distribution pipelines are not operating, trucks load fuel from PS-1 for delivery to the flightline.

The Bulk Fuels Storage Area and supply pipeline to the flightline are monitored for leakage through a combined effort of inventory control, pressure testing and tracer analysis. Inventory of the fuel in the four tanks is conducted on a daily basis. The supply lines extending from the tanks to the flightline are pressure tested on an annual basis and the last test was completed in August, 1995. The testing procedure is outlined in AFM 85-16 and it requires the lines to be pressurized to 1.5 times normal system pressure. The lines are also tested by means of tracer.

analysis. Tracer Research Inc. has tested the lines in 1991, 1992, 1993 and most recently in August, 1995. a volatile tracer chemical is added to the fuel in the tanks and it is allowed to travel throughout the lines. All of this testing over the past few years has been satisfactory. In addition, new tank bottoms have been installed in Tanks 1 and 4 and the design of new tank bottoms for Tanks 2 and 3 is complete. The project will be ready to advertise in October 1995.

IRP activities have been ongoing at PS-1 since 1986. Samples from shallow monitoring wells collected regularly from 1986 through 1991 yielded inconsistent concentrations of BTEX constituents and other VOC. In 1990 Fairchild AFB personnel encountered petroleum contaminated soil while installing a spill containment basin and tank near the fuel truck loading rack. A soil sample yielded barium, ethylbenzene, xylenes and petroleum. The source of the barium anomaly is unknown but it may be due to natural variations in soil composition. A ground water sample from the excavation contained benzene and other BTEX constituents.

During previous IRP activities in November 1991, the Air Force installed four monitoring wells, MW-194, MW-195, MW-196, and MW-197, into the shallow aquifer. Petroleum was detected at the method detection limit in MW-197. Lead detected in unfiltered ground water samples was attributed to suspended sediment in the samples, not to contamination at the site.

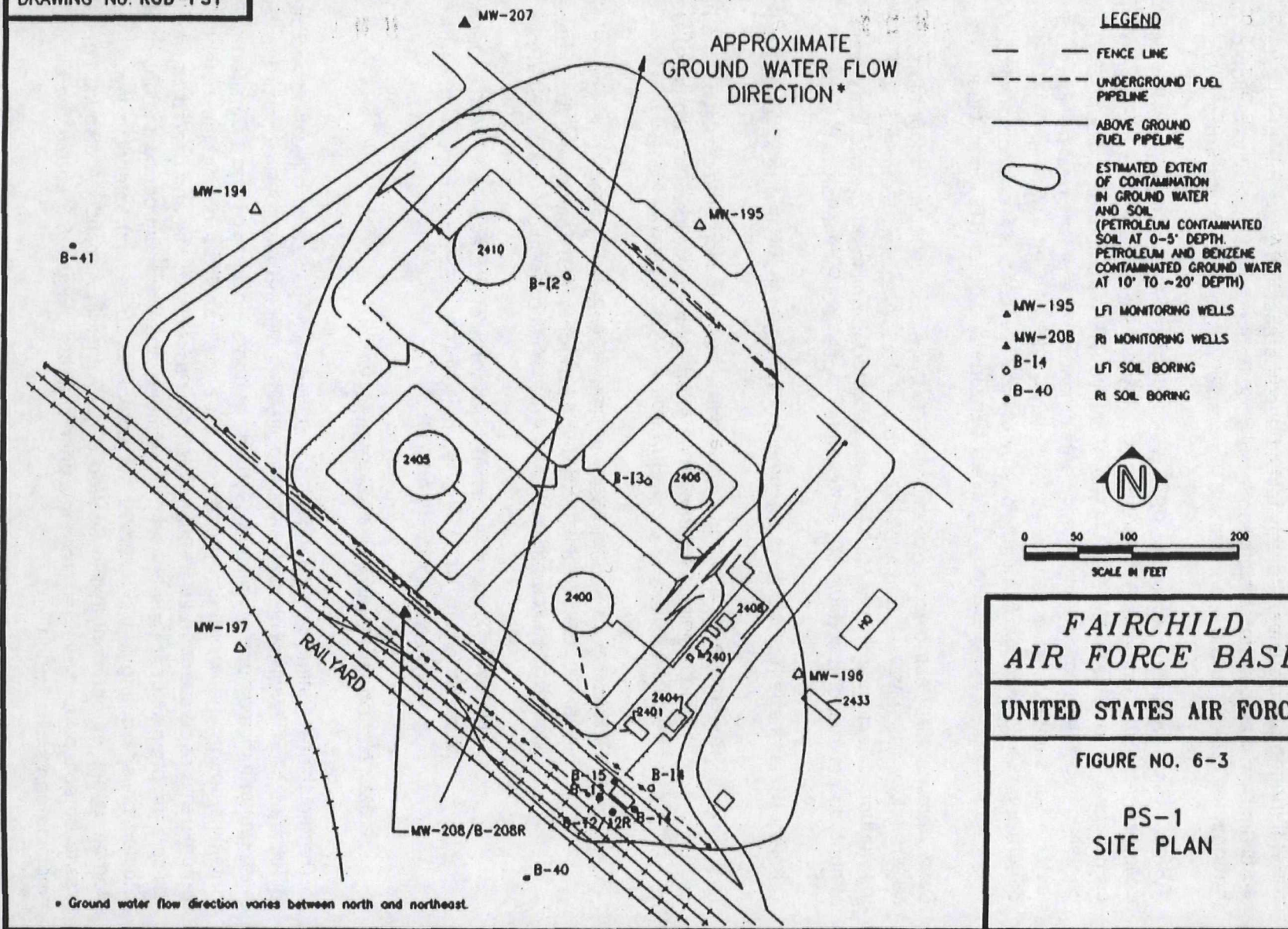
In recent years, the Air Force has documented evidence of three JP-4 releases at PS-1:

- **Release 1.** At a fuel transfer pipeline south of storage tank 2406. The Fairchild AFB Liquid Fuels Department reported approximately 4,500 gallons were released and 3,000 gallons recovered from a 1990 leak (Mason 1991).
- **Release 2.** At a fuel transfer pipeline near Building 2404. During an excavation at PS-1, the Fairchild AFB Civil and Environmental Engineering (CEE) department unearthed soil contaminated by an estimated 2,000 gallons of JP-4 (Rosa 1992).
- **Release 3.** Under the road bed north of storage tank 2410. During road construction in 1993 the Fairchild AFB CEE department unearthed JP-4 contaminated soil (Rosa 1993).

6.3.2. Nature and Extent of Contamination

The remedial investigation activities at PS-1 included a soil-gas survey, installing and sampling soil borings, and installing and sampling shallow monitoring wells. Results of the remedial investigation indicate approximately 37,900 yd³ of contaminated soil and 1.8 million gallons of contaminated ground water are present at PS-1. All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations. Figure 6-3 shows the extent of this remaining contamination.

DRAWING No. ROD-PS1



6.3.2.1 Subsurface Soils. Numerous VOC and SVOC were detected in soil borings surrounding the fuel truck loading pad. The borings in this area include B-12, B-12R, B-13, B-14, B-15, the MW-208 boring, and B-208R. Most of the compounds detected are known constituents of jet fuel. These include BTEX compounds, sec-butylbenzene, p-cymene, naphthalene, 2-methylnaphthalene, n-propylbenzene, isopropylbenzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene.

Concentrations of diesel range petroleum as high as 9,185 mg/kg were detected in soils north of the truck loading rack where fuel contamination was observed in 1990. Elsewhere across the site diesel range petroleum concentrations ranged from 7.5 mg/kg to 3,500 mg/kg.

Analyses show all metals concentrations are generally below or near site-specific natural background levels. A single detection of silver and cadmium in B-15 are the only occurrences of metals substantially above natural background levels in soils at PS-1. These values are attributable to natural variations in soil composition. Beryllium, manganese, and lead also exceeded natural background but by only a small amount, and the lead exceedance is confined to the LFI investigations. None of the RI lead analyses exceeded background.

6.3.2.2 Ground Water. In March 1993, the Air Force installed two monitoring wells, MW-207 and MW-208. With the exception of hexachlorobutadiene and two trichlorobenzene isomers, the VOC and SVOC detected in ground water were recognized either as constituents of JP-4 or degradation products of fuel constituents. Hexachlorobutadiene is a constituent of hydraulic fluids and is a solvent for natural and synthetic rubber products. It has often been observed in roadway runoff and may be a laboratory artifact. The two trichlorobenzene isomers (1,2,3- and 1,2,4-) are common laboratory solvents and are also likely laboratory artifacts.

Concentrations of petroleum in MW-208 ranged from 290 µg/L to 7,000 µg/L. The maximum concentration observed in MW-207 was 160 µg/L. Arsenic, selenium, barium, and manganese, were detected above natural background levels in filtered samples. The source of these metals in ground water is not known. Operations at PS-1 would not have required these metals nor caused them to accumulate.

MW-196 and MW-208 were the only wells displaying contaminant concentrations exceeding state ground water cleanup standards. Compounds detected in these wells include BTEX, petroleum, and various fuel related VOCs. Benzene was detected at concentrations exceeding the MTCA Method A cleanup standard four times in MW-208 and once in MW-196. Arsenic, manganese and selenium concentrations were also present in filtered water samples collected from these wells. Contamination in MW-208 was attributable either to contaminant migration along a utility corridor under the access thoroughway or from an undocumented release from the rail or truck headers. Migration of contaminants may occur along this utility corridor or along a water line which extends along the perimeter of the entire facility. Contamination in MW-196 is likely a result of impacts from Release No. 2 which occurred after installation of the well.

6.3.3 Summary of Site Risk

Vadose zone contamination encountered during the remedial investigation is present from the surface to 10 feet deep and was not detected below the upper 2 feet of a clay layer that was encountered across the site. This layer appears to prevent the downward migration of fuel residues.

Under present conditions, exposure to Site PS-1 ground water is unlikely. The base water supply is drawn from a source approximately ten miles from the base and is unaffected by contaminants in PS-1 ground water.

One current use receptor group was identified for PS-1: Air Force personnel and contractors. Other current receptor groups considered in this baseline risk assessment, on-base residents, base visitors, and trespassers were not evaluated for PS-1. However, exposures for hypothetical future residents to current concentrations were evaluated. The site is fenced with barbed wire and distant from areas where these receptor groups might be found.

6.3.3.1 Contaminants of Concern. For soil samples, the maximum concentration of beryllium exceeded risk screening levels and state soil cleanup levels that apply to this site. Manganese was retained as a potential contaminant of concern because it exceeded state cleanup levels and natural background levels. Therefore beryllium and manganese were evaluated in the risk assessment.

Seven volatile organic compounds were retained as potential contaminants of concern for PS-1 soils. All VOC detected in soil at PS-1 were at concentrations below their respective risk screening levels. Sec-butylbenzene, n-butylbenzene, p-cymene, 2-methylnaphthalene, n-propylbenzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were retained as potential contaminants of concern. These compounds are known constituents of refined fuel. In addition to these VOC compounds, petroleum hydrocarbons mixtures were detected in soil at a maximum concentration of 9,185 mg/kg.

For ground water samples, the concentrations of arsenic, barium, beryllium, manganese, and nickel exceeded their risk screening levels; however, the concentrations of barium, beryllium and nickel were lower than natural background levels and were not retained for further evaluation. Arsenic, Manganese, and selenium exceeded natural background levels and were retained for further evaluation.

Benzene, ethylbenzene, hexachlorobutadiene, isopropylbenzene, 1,2,4-trichloro-benzene, and xylenes exceeded their risk screening levels and were retained as potential contaminants of concern. In addition, sec-butylbenzene, p-cymene, 2-methyl-naphthalene, n-propylbenzene, 1,2,3-trichlorobenzene, 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene were retained as potential contaminants of concern. With the exception of hexachlorobutadiene and the two trichlorobenzene isomers, all of the organic compounds retained as potential contaminants of concern are recognized as either constituents of refined fuels or degradation products of fuel constituents.

6.3.3.2 Human Health Risk Assessment. For site PS-1, current risks, based on RME assumptions, under the Air Force Personnel/Contractor scenario are principally due to ingestion of benzene and arsenic contaminated ground water and round up to 1×10^{-3} . Current hazards under the same scenario are principally due to ingestion of manganese and arsenic contaminated ground water and round up to 12. Exposure to soils results in a risk of 2×10^{-7} , and a hazard of 4×10^{-2} , both below screening thresholds. Risk associated with petroleum contamination can not be quantified. The noncancer hazard and cancer risk associated with the ground water ingestion pathway are hypothetical and are based on possible future use of ground water containing contaminants at current concentrations. There currently are no residents at site PS-1 and the shallow water-bearing unit is not used as a domestic water supply.

6.3.3.3 Ecological Risk Assessment. There is no apparent ecological risk associated with conditions at PS-1. The ecological hazard quotient for benzene is between 0.3 and 0.4. The quotients of the other contaminants of concern are at least an order of magnitude less than one.

6.3.4 Conclusions

There is no unacceptable risk or hazard associated with exposure to PS-1 soil. Evaluation of the soils contamination at the site shows the state cleanup level for petroleum in soil is exceeded. For this reason, soil cleanup alternatives were evaluated.

Ingestion of contaminated ground water is the principal source of unacceptable cancer risk for the industrial exposure scenarios. In addition, the maximum benzene concentration significantly exceeds the MCL of $5 \mu\text{g/L}$, and concentrations of petroleum exceed state cleanup standards for ground water. For these reasons, ground water cleanup alternatives were evaluated.

6.4 SITE PS-5, FUEL OIL STORAGE TANK AT WHERRY HOUSING

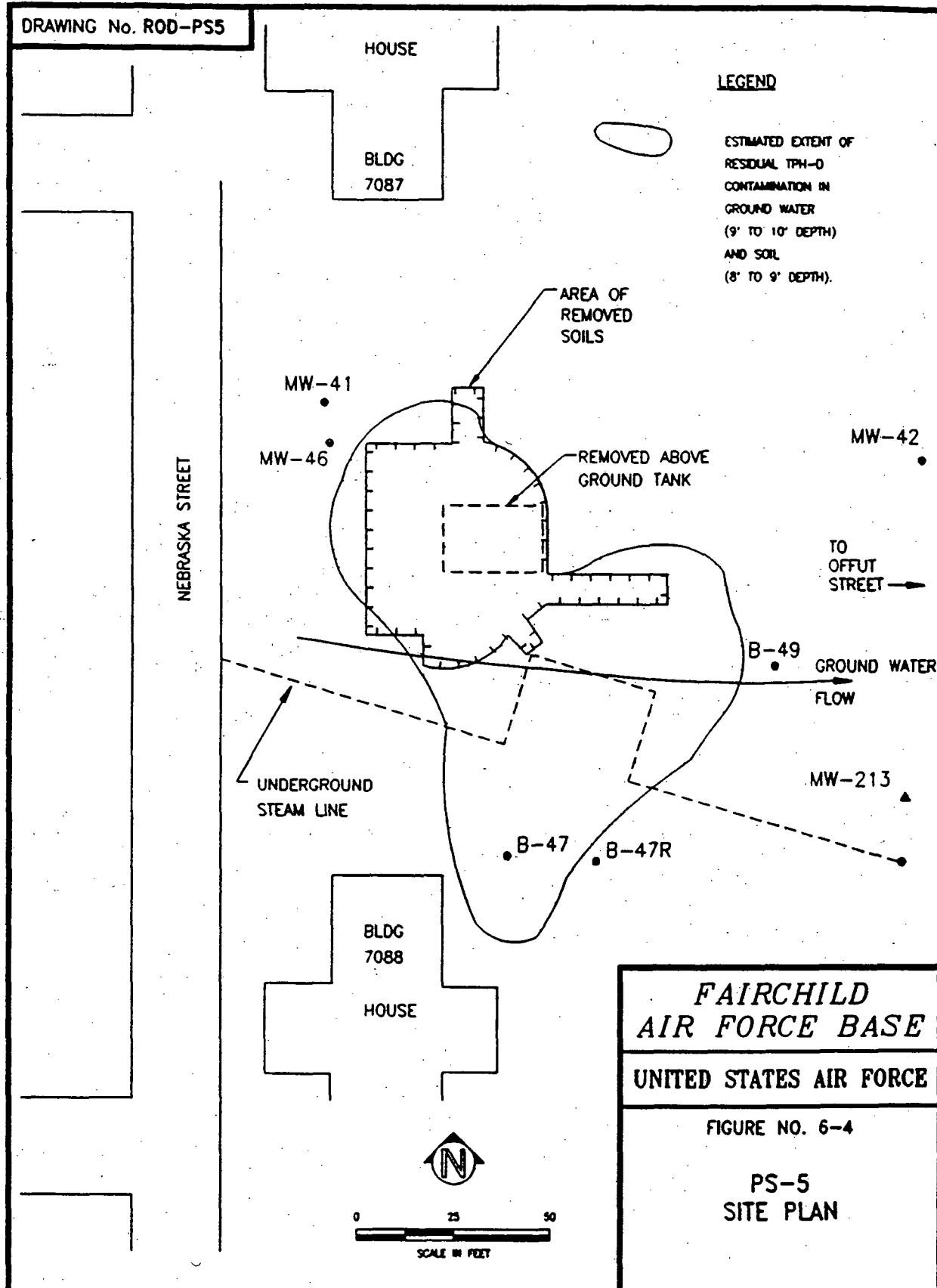
Site PS-5 is located in the west-central portion of Fairchild AFB along the eastern edge of the Wherry Housing Area, an on-base family housing development. The location of the site is shown in Figure 1-1; a site plan is presented as Figure 6-4.

6.4.1 Background

The source of observed environmental contamination is a 20,000-gallon above ground steel storage tank previously located at the site. The Air Force removed the tank in 1985. During its operational lifetime, the tank stored No. 2 heating oil for on-base residences. Soil and ground water contamination is attributed to uncontrolled releases of heating oil to the ground and to a dry well located at the former fuel loading platform.

Previous IRP investigations confirmed fuel residues were present in soils and ground water at the site. Petroleum concentrations up to 21,644 mg/kg in soil were detected. A total BTEX concentration of $8.6 \mu\text{g/L}$ was detected in ground water samples collected from monitoring wells

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at the site. In 1992 the Air Force proceeded with an independent removal action involving the excavation and offsite treatment of approximately 850 yd³ of petroleum-contaminated soil. The removal action successfully removed the majority of vadose zone contamination from the site.

6.4.2 Nature and Extent of Contamination

This section presents a detailed discussion of the individual field activities conducted at PS-5 during the remedial investigation. Approximately 185 yd³ of contaminated soil and 11,210 gallons of mildly contaminated ground water remain at PS-5. All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations. Figure 6-4 shows the estimated extent of this remaining contamination.

6.4.2.1 Geophysical Survey. The Air Force performed a terrain conductivity survey to assess the lateral extent of the phase-separated hydrocarbons observed during the independent removal action. A low conductivity anomaly observed on the west side of Offut Street extended beneath the street and occupied a small area on the east side of the street. The anomaly suggested a layer of phase-separated hydrocarbons. An intrusive investigation designed to evaluate this anomaly found no evidence of hydrocarbon contamination in waters or soils.

6.4.2.2 Subsurface Soils. Diesel range petroleum was detected in soils at 342 mg/kg in B-47, one of the five borings installed at this site. Samples from B-48 submitted for laboratory analyses yielded VOC at concentrations ranging from 0.033 mg/kg (chlorobenzene) to 0.066 mg/kg (1,1 dichloroethane). These data were rejected, however, due to laboratory quality failures. There was no evidence PS-5 represents a source for chlorinated organic compounds.

Field observations, boring logs, and laboratory analyses indicate soil contamination remaining at PS-5 is limited to the capillary fringe portion of the soil profile and is confined to the area immediately south of the former source area. No evidence of fuel saturated soils was observed during soil boring activities.

6.4.2.3 Ground Water. Diesel range petroleum concentrations were detected in all four existing wells at the site at concentrations ranging from 0.06 to 1.8 mg/L during spring and summer of 1993. Later sampling did not detect diesel range petroleum.

VOC in ground water are limited to substituted benzene compounds found in two wells. Low concentrations of sec-butylbenzene, isopropylbenzene, and 1,3,5- trimethylbenzene were reported in one well during the summer and fall of 1993, and sec-butylbenzene was detected slightly above detection limits in another well in the fall of 1993. These compounds are directly attributable to fuel residues. Concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, and zinc were detected in ground water above natural background levels.

6.4.3 Summary of Site Risks

The independent removal action successfully removed the majority of fuel contaminated soils. Contaminated soils remaining at the site are found in a thin (less than 12 inch), stratigraphic layer between 8 and 10 feet deep. The nature of the overlying soils (massive, organic-rich loam) significantly restricts the movement of volatile compounds. This reduces the potential for volatilization to the atmosphere, unless excavation activities expose remaining contamination.

Potential current receptors to environmental contamination at PS-5 are Air Force personnel and contractors, on-base residents, trespassers, and visitors to the site. Exposures for hypothetical future residents were also evaluated at current concentrations. Evaluations of migration pathways show that fuel residues in soil, ground water, and air are the only exposure pathways applicable to PS-5.

6.4.3.1 Contaminants of Concern. Comparing maximum soil contamination concentrations to screening levels shows diesel range petroleum as the only potential contaminant of concern. Samples from the side wall of the removal action excavation yielded a maximum of 6,700 mg/kg of diesel range petroleum. Although this concentration exceeds the state cleanup standard, it is representative of a small area only.

Comparison of the maximum concentrations of contaminants in groundwater revealed five metals and four organic compounds exceeding state cleanup levels or risk screening levels. Arsenic, cadmium, chromium, lead, and manganese were the metals identified as potential contaminants of concern. Among the organic compounds, benzene, sec-butylbenzene, 1,3,5-trimethylbenzene, and xylenes were identified as potential contaminants of concern. Heating oil No. 2 was also identified as a potential contaminant of concern.

6.4.3.2 Human Health Risk Assessment. For site PS-5, current risk and hazard, based on RME assumptions, under the residential exposure scenario can be calculated only for ground water exposure. For site PS-5, current calculable risks and hazards under the residential exposure scenario are principally due to ingestion of manganese and arsenic contaminated ground water and round up to values equivalent to the site cumulative values of 1×10^{-3} for risk and 30 for hazard. Both risk and hazard associated with exposure to PS-5 ground water exceed acceptable levels. At present ground water exposure pathways are incomplete and may never exist given the adequacy of the base water supply system. It is not possible to quantify the risk for petroleum contaminated soil and ground water.

6.4.3.3 Ecological Risk Assessment. Based on the nature and extent of observed contamination and potential exposure pathways, the Air Force concludes there is no apparent ecological risk to target species at PS-5.

6.4.4 Conclusions

Ingestion of manganese and arsenic contaminated ground water is the principal source of unacceptable risk and hazard at PS-5. But under present conditions, exposure to Site PS-5 ground water is unlikely. The base water supply is drawn from a source approximately ten miles

from the base and is unaffected by contaminants in PS-5 ground water. However, concentrations of petroleum in soil and ground water exceed state cleanup levels and petroleum contaminated soil is a potential source of ground water contamination. Therefore, soil and ground water cleanup alternatives were evaluated.

6.5 SITE PS-7, DEEP CREEK STEAM PLANT, BUILDING 1350

Site PS-7 is located in the south central portion of Fairchild AFB and is part of the Air Force Survival School. A site location map is provided in Figure 1-1. The site formerly used two 12,000 gallon and one 500 gallon UST that supplied fuel to the Deep Creek Steam Plant in Building 1350. A site plan for PS-7 is presented in Figure 6-5.

6.5.1 Background

Contaminants of concern at PS-7 are residual constituents of No. 6 and No. 2 fuel oil. Two 12,000 gallon USTs were used to store No. 6 oil that fueled the two steam plant boilers located inside Building 1350. A 500 gallon UST stored No. 2 fuel oil for preheating the boilers. Prior to 1982, waste solvents from maintenance activities at Fairchild AFB were added to the larger USTs and burned with the No. 6 oil. In 1988, the Air Force converted the boilers to burn No. 2 fuel oil exclusively. This conversion included the installation of a 10,000 gallon above ground tank, and removed the UST system from service. During the history of the steam plant, Fairchild AFB personnel observed fuel oil and ground water seeping through cracks in the steam plant subgrade foundation.

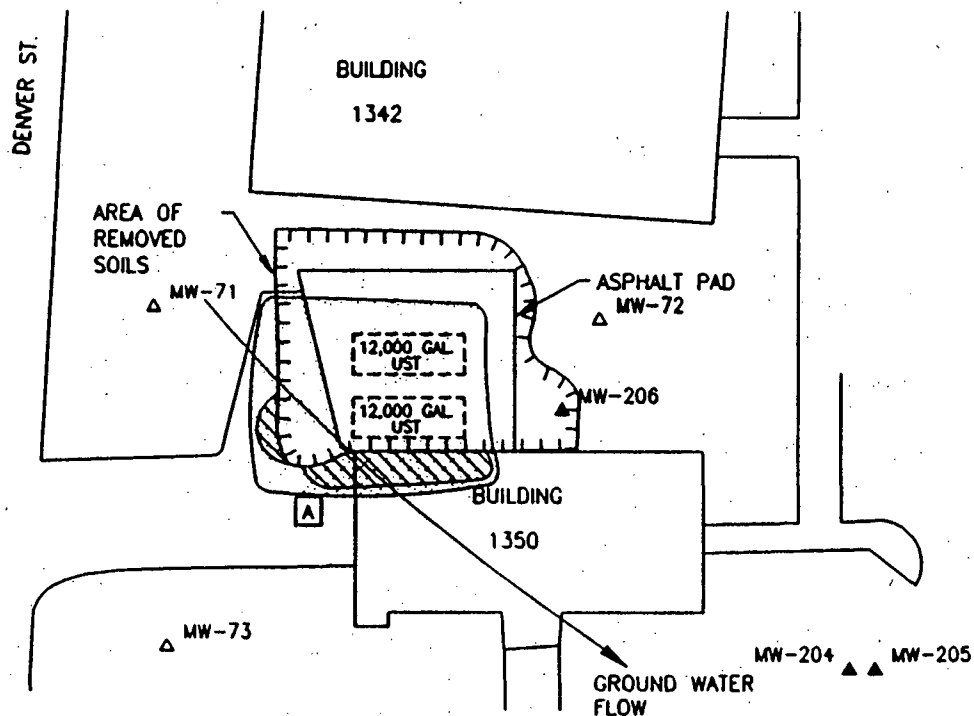
IRP investigations conducted between October 1986 and June 1989 included the installation and sampling of eight soil borings and three ground water monitoring wells. Results of sampling reported the presence of petroleum contamination in soil at concentrations up to 1,439 mg/kg. Ground water analyses did not detect the presence of petroleum contamination.

In 1992, the Air Force conducted an independent removal action at PS-7 that involved the closure and removal of the three USTs. During the removal action, the Air Force contractor excavated approximately 400 yd³ of petroleum-contaminated soil. Samples collected during the removal action indicate petroleum concentrations above the state cleanup level of 200 mg/kg are still present along the northern edge of Building 1350 and along the western edge of the former UST excavation. The maximum petroleum concentration, 8326 mg/kg, was detected at a depth of 9.5 feet in the southwest corner of the excavation.

6.5.2 Nature and Extent of Contamination

The remedial investigation at PS-7 included installing and sampling three ground water monitoring wells to determine the presence or absence of petroleum residues in ground water. Three pre-existing monitoring wells were also sampled. The remedial investigation determined approximately 60 yd³ of petroleum contaminated soil and 84,000 gallons of petroleum contaminated ground water are still present at PS-7. All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific

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LEGEND

- A ABOVE GROUND TANK
CURRENTLY IN USE
- UST FORMER UNDERGROUND FUEL
STORAGE TANK LOCATIONS
- EXTENT OF TPH-D
CONTAMINATION
IN SOIL
(0 TO 6" DEPTH)
- ESTIMATED EXTENT OF
TPH-D CONTAMINATION
IN GROUND WATER
(6 TO 21" DEPTH)
- ▲ MW-205 MONITORING WELL AND NUMBER
- △ MW-72 LFI MONITORING WELL AND NUMBER



**FAIRCHILD
AIR FORCE BASE**

UNITED STATES AIR FORCE

FIGURE NO. 6-5

PS-7
SITE PLAN

risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations. Figure 6-5 shows the estimated extent of this remaining contamination.

6.5.2.1 Ground Water. The Air Force installed three monitoring wells to assess petroleum contamination in the shallow aquifer at PS-7. Ground water samples were collected from the three new wells and from three existing monitoring wells (MW-71, MW-72, and MW-73) quarterly for one year, commencing in April 1993.

Chloroform was detected in wells MW-71, MW-73, and MW-204 at a maximum concentration of 7.5 µg/L. Bromodichloromethane was detected in MW-71 in October 1993 and in MW-71, MW-73, and MW-205 in January 1993. In all cases, bromodichloromethane was detected with chloroform. These two compounds may originate from the chlorinated water supply used to irrigate the lawns at this site. Chlorination of potable water is known to produce both of these compounds. Other VOC detected in ground water samples included naphthalene, 1,2,4-trimethylbenzene, 1,4-dichlorobenzene and 1,2,3-trichlorobenzene.

SVOC detected in the ground water samples included bis(2-ethylhexyl)phthalate, benzyl alcohol, and 2-methylphenol at maximum concentrations of 14 µg/L, 30 µg/L, and 21 µg/L, respectively.

Petroleum detected in ground water samples from MW-206 at a maximum concentration of 2,300 µg/L in October 1993. Petroleum was also detected in October 1993 in wells MW-72 at 3,200 µg/L and in MW-73 at 1,200 µg/L. No petroleum was detected in the April 1993, July 1993, or January 1994 ground water samples from these wells.

No metals above natural background levels were detected in any ground water samples.

6.5.3 Summary of Site Risks

The sources of contamination (the two 12,000-gallon UST containing No. 6 fuel oil and the 500 gallon UST containing No. 2 fuel oil) have been removed and contaminated soil remediated at PS-7. Although some contaminated soil does remain on the site, No. 6 fuel oil is immobile in the environment and is not expected to migrate from the source area. No. 6 fuel oil has not been detected in ground water collected from wells on the site, except at MW-206 and only during the October 1993 sampling activity. No petroleum was detected from this well during the next sampling round.

No. 6 fuel oil has an extremely low volatility, so air is not considered as a migration pathway. The site is covered with clean fill, asphalt, and buildings; therefore, contaminated dust and the venting of any volatile compounds from the subsurface soil is negligible.

Because the residual petroleum contamination is several feet below ground surface, contact with this residue is limited to Air Force personnel or contractors performing excavations at the site. However, exposures for hypothetical future residents to current concentrations were also evaluated.

6.5.3.1 Contaminants of Concern. Chloroform and bromodichloromethane detected in the ground water may originate from the chlorinated potable water supply used for irrigating the lawn or from leaky water pipes at PS-7. Process information and the history of operations at PS-7 does not indicate any other sources for these compounds. They are carcinogens, however, so they were included as potential contaminants of concern.

The concentrations of manganese in ground water exceed the risk screening level, but did not exceed natural background levels. Manganese was not considered a concern at PS-7 because its concentration was well below basewide natural background levels. Petroleum in ground water is a contaminant of concern. However, the risk from exposure to petroleum is not quantifiable.

IRP investigations indicate that components of No. 6 fuel oil are the only contaminants present in soil. During the independent removal action conducted in 1992, soil samples detected fuel constituents ranging in concentration from 400 to 8,326 mg/kg. Although toxicity parameters do not exist for No. 6 fuel oil, it was included as a potential contaminant of concern and was evaluated for noncancer hazard.

6.5.3.2 Human Health Risk Assessment. For site PS-7, current risk and hazard, based on RME assumptions, under the Air Force Personnel/Contractor scenario can be calculated only for ground water exposure. For site PS-7, current calculable risks and hazards under the Air Force Personnel/Contractor scenario are principally due to ingestion of chloroform and bromodichloromethane contaminated ground water and round up to 3×10^{-7} for risk and 4×10^{-3} for hazard. Neither of these values exceeds screening thresholds. Risk associated with petroleum contaminated soil and ground water can not be quantified.

6.5.3.3 Ecological Risk Assessment. Site PS-7 does not provide good habitat for wildlife. There are no contaminants of concern nor complete exposure pathways to target species or plant communities at the site. Because there is no evidence the site impacts target species or plant communities, there is no apparent ecological risk at PS-7, and ecological quotients were not developed.

6.5.4 Conclusions

Under present conditions, exposure to ground water at PS-7 is unlikely. The base water supply is drawn from a source approximately ten miles from the base and is unaffected by contaminants in PS-7 ground water. The Air Force is reviewing plans to demolish Building 1350, at which time steps would be taken to manage and dispose of the remaining petroleum contaminated soil in accordance with all applicable federal, state, and local regulations.

Evaluation of the remaining soil and ground water contamination at PS-7 shows there are no exceedances of risk or hazard screening thresholds. Petroleum concentrations in soil and ground water exceed state cleanup levels, and since petroleum contaminated soil is a potential source of ground water contamination, soil and ground water cleanup alternatives were evaluated.

6.6 SITE PS-10, FUEL TRUCK MAINTENANCE FACILITY, BUILDING 1060

PS-10 is located on the west side of Fairchild AFB, south of the fuel truck maintenance shop (Building 1060), north of Parallel Taxiway 1, and northeast of Priority 1b SW-1. The location of PS-10 is shown on Figure 1-1. The source of contamination at PS-10 is an unlined drainage ditch that begins approximately 100 feet south of Building 1060. There is visible evidence of petroleum contamination along the ditch. A site plan for PS-10 is shown in Figure 6-6.

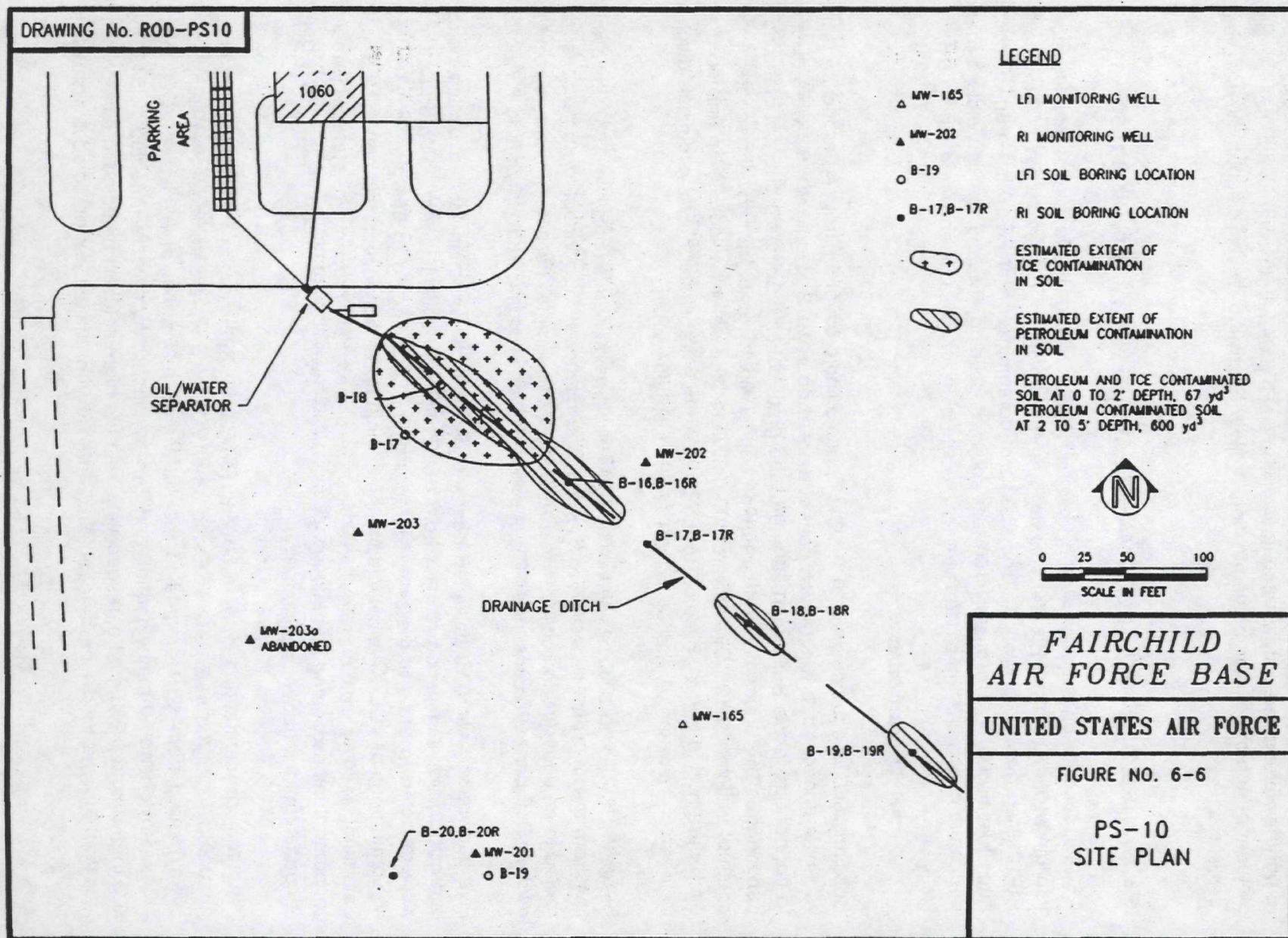
6.6.1 Background

Building 1060 was constructed in 1959 to house a liquid oxygen/nitrogen production facility. It was later converted to a corrosion control paint shop in 1973. Liquid wastes were discharged to floor drains inside Building 1060 and to the grate-covered concrete channel in the adjacent parking lot. The drains and the concrete channel discharge to an oil/water separator located south of Building 1060. Overflow from the oil/water separator flowed into an unlined drainage ditch designed to convey overflow to the base storm water system. The chemicals discharged to the ditch were mostly lubricating oils and industrial cleaners.

Since 1981, Building 1060 has served as a fuel truck maintenance facility. In 1987, the discharge line from the oil/water separator to the drainage ditch was disconnected and discharge was routed to an underground collection tank. Shallow soil samples collected in and adjacent to the ditch in October 1990 contained TCE at concentrations ranging from 6.0 $\mu\text{g/L}$ to 8.7 $\mu\text{g/L}$.

Five surface soil samples collected near the oil/water separator in 1991 exhibited petroleum hydrocarbon contamination ranging from 1,602 mg/kg to 14,911 mg/kg. TCE and other VOC were detected in three of the samples ranging from 0.01 mg/kg to 56.8 mg/kg. The highest concentrations of VOC were detected in the sample collected closest to the oil-water separator. Cadmium, lead, chromium, thallium, and zinc were all present in surface samples at concentrations exceeding natural background levels; both cadmium and thallium were detected at concentrations above regulatory levels.

Petroleum concentrations in three borings (B-17, B-18, B-19) ranged from 33,223 mg/kg at the surface to 73 mg/kg at 6 feet. TCE and other VOC also were detected in the samples. TCE levels ranged from 581.1 mg/kg at the surface to 0.2 mg/kg at 6 feet. SVOC, including 2,4-dimethylphenol, 2-methylphenol, and 2-methylnaphthalene, were detected at 54.8 mg/kg, 62.5 mg/kg, and 0.238 mg/kg, respectively, with the highest levels detected in surface samples (less than 6 inches below the surface). Bis(2-ethylhexyl)phthalate was detected in eight of eleven



soil samples ranging from 0.2 to 13.4 mg/kg. Thallium was the only metal detected above natural background levels in samples from these borings. Sampling results suggest TCE contamination in site soil is due to discharges of liquid industrial waste from the Building 1060 oil/water separator. The RCRA waste code for TCE is F001.

6.6.2 Nature and Extent of contamination

The Air Force installed monitoring wells and soil borings, and collected soil and ground water samples as part of the remedial investigation at PS-10. Based on information gathered during this remedial investigation, The Air Force estimates approximately 67 yd³ of TCE and 600 yd³ of petroleum contaminated soil remain in the ditch at PS-10. All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations. Figure 6-6 shows the estimated extent of this contamination.

6.6.2.1 Seismic Survey. The Air Force conducted a seismic refraction survey to better assess the depth and configuration of the basalt bedrock surface encountered during monitoring well installation. Interpretation of well logs in combination with results of the seismic survey identified three major stratigraphic layers: (1) an alluvial veneer ranging from 0 to 45 feet thick; (2) a highly weathered basalt rubble with intermixed sands and silts; and (3) basalt bedrock. A scour channel in the bedrock generates a change in alluvial thickness of 35 feet over a horizontal distance of 50 feet. Unconfined ground water is seasonally present in the alluvium. Confined ground water occurs in the bottom portion of the weathered basalt layer. Contacts between stratigraphic layers act as barriers to the vertical migration of ground water.

6.6.2.2 Subsurface Soils. Five soil borings (B-16 through B-20) were installed at PS-10 in March 1993. Five additional borings (B-16R through B-20R) were drilled at PS-10 in October 1993.

VOC contamination occurs primarily at a depth of 6 to 10 feet and most often is concentrated at a depth of 6 to 8 feet. Known fuel constituents and their degradation byproducts including ethylbenzene, toluene, xylenes, t-butylbenzene, naphthalene, p-cymene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene are present above detection limits. Methylene chloride was observed at a maximum concentration of 0.02 mg/kg, and 1,1-dichloroethene was observed at a maximum concentration of 0.13 mg/kg. Methylene chloride is a common laboratory contaminant. TCE was not detected in soil samples collected in 1993, only in soils in 1991.

Petroleum were observed in all borings except B-20. Petroleum concentrations appear close to the surface with concentrations up to 4,140 mg/kg in soils at B-18, and decrease with depth to about 4 feet. Below 4 feet deep, petroleum was not detected in soils. The highest concentrations of petroleum were detected in surface soils collected during the 1991 investigation.

Metals above natural background levels were observed at a depth of 6 to 10 feet deep in B-16 through B-20. These concentrations, however, approximate natural background levels. Cobalt and lead slightly exceed their respective natural background levels. Metals concentrations above natural background levels were not observed in any other depth intervals except at B-16 where cadmium, chromium, and copper were detected from the surface to 2 feet deep at concentrations exceeding twice natural background levels.

Thallium was detected in the three soil borings and several surface soil samples collected in 1991, but not during subsequent sampling events using more sophisticated analytical methods. This suggests thallium detected during this previous IRP investigation may be due to spectral interference from aluminum; a common occurrence for the analysis used during the 1991 investigation.

6.6.2.3 Surface Soils. Three surface soil samples were collected from the surface depression in March 1994 to assess if TCE and petroleum concentrations had decreased since the earlier surface sampling events. TCE concentrations were measured at 73.2 mg/kg, 5.36 mg/kg, and 65.0 mg/kg. Petroleum concentrations were 15,000 mg/kg, 36,000 mg/kg, and 32,000 mg/kg. Comparison of these results with the earlier analyses are inconclusive as to the natural degradation of TCE and petroleum in surface soil at PS-10.

6.6.2.4 Ground Water. The Air Force constructed three ground water monitoring wells (MW-201, MW-202 and MW-203) at PS-10. MW-165 was installed during previous IRP investigations at Priority 1 Site SW-1.

TCE and cis-1,2-dichloroethene were detected in samples collected from MW-201 and MW-202 at concentrations above the MCL of 5 µg/L and 70 µg/L, respectively. Maximum concentrations were 410 µg/L in MW-201 and 830 µg/L in MW-202. These compounds were also detected in MW-165, but at much lower concentrations. Trans-1,2-dichloroethene, another degradation by-product of TCE, was observed in the MW-201 sample collected in July 1993 at a concentration of 3.0 µg/L.

Bis(2-ethylhexyl)phthalate was the only SVOC detected during ground water sampling. It was detected at a concentration of 24 µg/L in the MW-202 sample from April 1993. Petroleum was not detected in ground water samples above laboratory detection limits. No metals (total or dissolved) were detected above natural background levels.

6.6.3 Summary of Site Risks

The results of the IRP investigations indicate TCE and several degradation by-products are concentrated in the soil in the surface depression adjacent to the former discharge line and drainage ditch. Cis-1,2-dichloroethene was detected at a maximum depth of 6 to 8 feet deep. Petroleum were detected along the entire extent of the drainage ditch, but are mainly concentrated in surface and near surface soils (less than 2 feet deep). Petroleum were not detected in ground water at PS-10, but future migration to ground water is possible.

The potential exists for release of contaminants into air if contaminated soils are disturbed. The concentration of contaminants in the soil are low, therefore, air does not appear to be a primary migration pathway.

PS-10 is located next to the flightline in a light industrial zone that is fenced with barbed wire and routinely patrolled by Air Force Security. Access to the site is limited to Air Force personnel and contractors. There are no residential areas adjacent to PS-10 and no other attractions that might induce trespassers or visitors to the site. Therefore, Air Force personnel and contractors are the only receptor group that will be evaluated for the current use scenario. However, exposures for hypothetical future residents were also evaluated.

6.6.3.1 Contaminants of Concern. Four metals and eight organic compounds were retained as potential contaminants of concern for soil at PS-10. Cobalt and lead slightly exceeded their respective natural background levels. Manganese exceeded the state cleanup level and the natural background levels. Thallium exceeded the state soil cleanup level, the risk screening level for noncancer effects, and the natural background levels.

Organic compounds identified as potential contaminants of concern for soil are t-butylbenzene, p-cymene, petroleum, and 1,2,4- and 1,3,5-trimethylbenzene. There are no screening criteria for these compounds and risks associated with exposures can not be quantified because there is no toxicity data. Other organic compounds identified as contaminants of concern include bis(2-ethylhexyl)phthalate which exceeded the risk screening level for carcinogenicity, TCE which exceeded the state cleanup level and the risk screening level for carcinogenicity.

One metal and four organic compounds were identified as potential contaminants of concern in the ground water at PS-10. Cadmium was present at a concentration that slightly exceeded the risk screening level for noncancer effects. Cis-1,2-Dichloroethene exceeded the MCL, state ground water cleanup level, and the risk screening level for noncancer effects. Bis(2-ethylhexyl) phthalate and TCE exceeded their respective MCLs, state cleanup levels, and risk screening levels for carcinogenicity. Sec-butylbenzene was identified based on the lack of screening concentration levels.

6.6.3.2 Human Health Risk Assessment. For site PS-10, current hazard, based on RME assumptions, under the Air Force Personnel/Contractor scenario are principally due to ingestion of manganese and thallium contaminated soils creating a hazard that rounds up to 0.2, which is below the screening threshold. Current cumulative risk under the same scenario is principally due to ingestion of TCE contaminated soil creating a risk that rounds up to 1×10^{-6} , which is within the acceptable range. These values do not include risk or hazard related to site ground water, because contamination in ground water will be evaluated under the Priority 3 Operable Unit. It was, nevertheless, evaluated in the RI and is presented in the tables in Appendix A. Risk due to exposure to petroleum contaminated soil can not be quantified.

6.6.3.3 Ecological Risk Assessment. The ecological quotients for target species exposed to the contaminants of concern are at least an order of magnitude less than 1.0. Therefore, the ecological risk to target species at the site is not a concern.

6.6.4 Conclusions

Under present conditions, exposure to PS-10 ground water is unlikely. The base water supply is drawn from a source approximately ten miles from the base and is unaffected by contaminants in PS-10 ground water. Petroleum and TCE contamination in soils at PS-10 may volatilize to the ambient air or leach to ground water. Petroleum was not detected in ground water at PS-10, but future migration to ground water is possible. TCE was detected in site ground water. Ground water contamination at PS-10 will be addressed under the Priority 3 Operable Unit.

The results of the risk assessment indicate exposure to TCE contaminated soil at PS-10 does not pose an unacceptable risk or hazard. The maximum petroleum and TCE concentrations in ditch soils significantly exceeds their state cleanup levels, and petroleum and TCE in soil could serve as a source for ground water contamination. For these reasons, soil cleanup alternatives were evaluated.

6.7 SITE SW-11, FORMER AIRCRAFT RECLAMATION YARD AT WHERRY

Site SW-11 is located in the north central portion of Fairchild AFB southwest of Building 2245. A location map is provided in Figure 1-1. Currently, the site consists of a park (Warrior Park) and recreational area. Formerly, this area served as an aircraft salvage and reclamation facility. A site map is presented in Figure 6-7.

6.7.1 Background

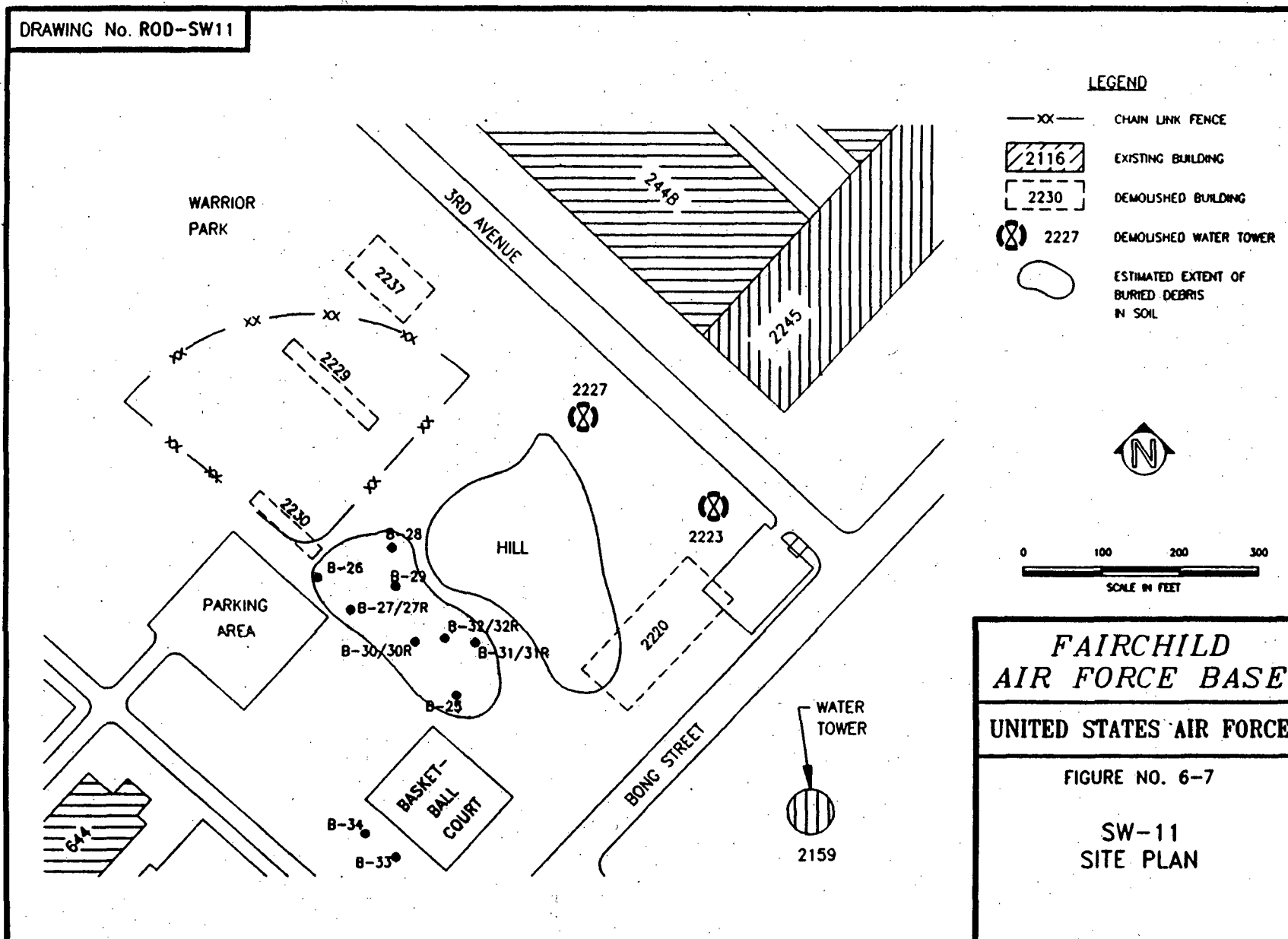
A thorough search of available records found no mention of any potential contamination at SW-11. Aerial photographs show the site was an active salvage yard from approximately 1945 through 1958. Approximately 10% of the former salvage yard site is currently covered with grass; 90% of the site surface is unvegetated consisting of packed soil and fill material.

Investigations in 1991 at SW-11 included a geophysical survey, six test pits, and collection of soil samples. The first three test pits were excavated to determine if debris was buried at SW-11. The last three test pits were excavated to investigate anomalies in the geophysical survey results. While excavating the test pits, scattered pieces of metallic debris were observed protruding through the excavated soil surface across the site.

Samples collected from soils in a utility trench dug around the perimeter of the site contained silver, barium, cadmium, antimony, thallium, zinc, and lead above natural background levels.

An assessment of engine valves removed from the excavations concluded the valves present a potential safety hazard because some of the valves contain 10 to 15 grams of elemental sodium which reacts violently if exposed to water.

SW-11
SITE PLAN



No site specific ground water investigations were performed during any previous investigations at SW-11. Ground water was not encountered in any of the test pits or boreholes. Regional mapping indicates depth to ground water is approximately 17 feet. Because of the low mobility of metal contamination and lack of apparent soil contamination at depth, ground water was not considered a source or pathway for metals contamination.

6.7.2 Nature and Extent of Contamination

The remedial investigation field activities at SW-11 included installing and sampling hand augered soil borings. All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations.

6.7.2.1 Soils. Activities in March 1993 at SW-11 included installation of ten shallow soil borings and collection of soil samples. In July 1993, four borings were re-drilled adjacent to the original boring locations. Soil samples were collected continuously at 1/2-foot intervals to a depth of 3.5 to 4.0 feet. Debris was encountered in several of these borings including wire mesh material and scraps of metal, and pea-sized shards of oxidized metals.

Arsenic, cadmium, chromium, cobalt, copper, lead, and nickel detected at concentrations above local natural background levels were the contaminants of initial concern at this site. The maximum concentrations of these metals were detected in B-30 and B-32 with concentrations above state cleanup levels for arsenic, cadmium, chromium, and lead observed in B-25, B-26, B-27, B-28, B-30, and B-32. Samples collected near the surface (0.0 to 0.5 feet) contain the most metallic debris, but these soils consist of hard packed fill material. The least contaminated interval is between 1.5 feet and 2 feet deep. The deepest interval shows an intermediate level of contamination. High concentrations of metals are often associated with metallic debris observed in soil samples.

Analysis of samples by particle size showed metals contamination preferentially adheres to fine grained sediment particles less than 53 μm in diameter. Chromium and lead show the strongest tendency to adhere to this potentially respirable sediment fraction, followed by cadmium and copper. Arsenic, cobalt, and nickel show no strong grain size preference.

To determine the ability of contaminants to leach into the vadose zone or into ground water, soil sampling was extended several feet below the deepest observed debris. If contaminant leaching were consequential, high concentrations of metals would be expected in the soil column immediately beneath the near surface debris layer. The lack of cadmium, chromium, and lead contamination in soil samples between 1.5 feet and 2 feet suggests leaching of these constituents is not significant. Leachability tests performed showed less than 0.1% of metals would leach from the soil column, even in saturated conditions.

With the exception of thallium, metal concentrations detected during the remedial investigation were consistent with those found during previous IRP investigations. Evidence suggests the ICP thallium detections were due to analytical interference and are likely representative of aluminum concentration.

6.7.3 Summary of Site Risks

Because of the low mobility of metals contamination and the lack of apparent soil contamination at depth, ground water is not considered a source or pathway for metals contamination.

Most of the year, the prevailing wind at Fairchild AFB is from the southwest with an average annual wind speed of 6 to 10 miles per hour. During the winter months wind is typically from the east-northeast. Calm conditions occur approximately 20% of the year. Maximum exposure to fugitive dust from SW-11 is expected to occur down wind, i.e., northeast and to a lesser extent west-southwest, from the site. Approximately 10% of SW-11 is covered with turf grass which reduces fugitive dust emissions. Runoff from the site flows toward the adjacent streets and is collected in storm drains. In addition, the upper portions consist of hard packed fill material which does not generate excessive dust.

Because soil contamination is generally greatest near the surface and because SW-11 is located in an area easily accessible, the potential receptor groups include Air Force personnel, contractors, on-base residents, visitors, and trespassers.

6.7.3.1 Contaminants of Concern. No solvents, fuels, or other organic compounds or mixtures were identified as potential contaminants of concern during site scoping activities. Therefore, analysis of soil samples was limited to metals. Ground water was not identified as a media of concern and was not evaluated during this investigation.

Four metals were identified as potential contaminants of concern. Arsenic exceeded the risk screening level based on carcinogenicity and the state cleanup level. Cadmium exceeded the risk screening level based on noncancer effects and the state cleanup level. Copper exceeded the risk screening level based on noncancer effects. Lead exceeded the site natural background levels and the basewide natural background levels. Lead also exceeded the screening level EPA has established for cleanup of residential areas, 400 mg/kg.

6.7.3.2 Human Health Risk Assessment. For site SW-11, current risk and hazard are principally due to ingestion of arsenic and cadmium contaminated soil. Based on RME assumptions, under the Air Force Personnel/Contractor scenario, cumulative site risk and hazard are 2×10^{-6} and 0.09, respectively, both of which are in or below the acceptable range.

The hard packed nature of the unvegetated surface soil impedes the exposure process by which all of these risks are generated.

6.7.3.3 Ecological Risk Assessment. There is no significant ecological risk from contaminants of concern to target species at SW-11.

6.7.4 Conclusions

The physical hazard from sharp metallic debris in the soils is considered a complete exposure pathway even though the metallic debris at SW-11 lies beneath a layer of hard packed fill. Additional hazards are aircraft engine valves containing metallic sodium, distributed from near the surface to several feet below ground level. The sodium in the valves represents a physical hazard if exposed to moisture because elemental sodium reacts violently with water. Investigation of the valves indicates they are slowly corroding in the subsurface where the sodium would be released slowly and react harmlessly.

Because there is no unacceptable risk or hazard, there is no exposure to metals contamination, and the contamination consists largely of fragments, shards, and particles of metallic debris, no remedial action to address chemical hazards is necessary. In order to reduce the possibility of human contact with the physical hazards at the site (metallic debris and elemental sodium), the Air Force will consider covering the site with several inches of topsoil and establishing turf grass. Institutional controls will further restrict site activity to prevent or oversee intrusive activity.

6.8 SITE FT-2, FORMER FIRE TRAINING AREA

The site is a former fire training area located on the east side of Fairchild AFB, south of abandoned Taxiway No. 10, west of the current fire training area, and north of the Weapons Storage Area. The site is currently inactive. The most conspicuous feature near FT-2 is a large pile of asphalt debris left over from runway construction in 1958. A wind sock located at the edge of the taxiway is a site landmark. Figure 1-1 shows the site location.

6.8.1 Background

Previous IRP investigations completed in 1991 identified stained and discolored soil, petroleum odors, and areas of suppressed vegetation at the FT-2 Site. Further studies confirmed the presence of petroleum contaminated soils beneath the largest area of suppressed vegetation. Interviews with Air Force personnel familiar with the site and review of historic documentation confirmed this area was used for fire training activities during the 1950s and 1960s.

Partially buried metallic debris was visible on the south side of the site, including fragments of steel matting used for temporary runway surfaces, aircraft parts (apparent air-foil and fuselage sections), and metal scraps. A terrain conductivity survey was performed to determine the extent of this debris. It identified buried metallic objects which were later identified as metal debris, a corroded and collapsed steel barrel, and steel wire during test pit excavations.

Soil samples collected during 1991 contained residues of AVGAS and JP-4 (BTEX, diesel range petroleum, and lead), and metallic debris from engines and aircrafts.

6.8.2 Nature and Extent of Contamination

The remedial investigation at FT-2 included installing shallow monitoring wells, drilling soil borings, collecting ground water samples, and collecting surface and subsurface soil samples. Investigation results identified approximately 5,600 yd³ of petroleum contaminated soil and 176,000 gallons of petroleum contaminated ground water present at the site. The highest chemical concentrations in soil were located in the suppressed vegetation zones in the center of the site. All analytes having the potential to be contaminants of concern are listed, along with their associated risk and hazard, in site specific risk screening tables in Appendix A. In these tables, the maximum concentrations of analytes detected on site during the LFI and RI are compared to several screening levels (for more information see introductory text in Section 6.0). Tables in Appendix A also list frequency of analyte detections and average analyte concentrations. Figure 6-8 shows the extent of subsurface fuel residue contamination identified at FT-2.

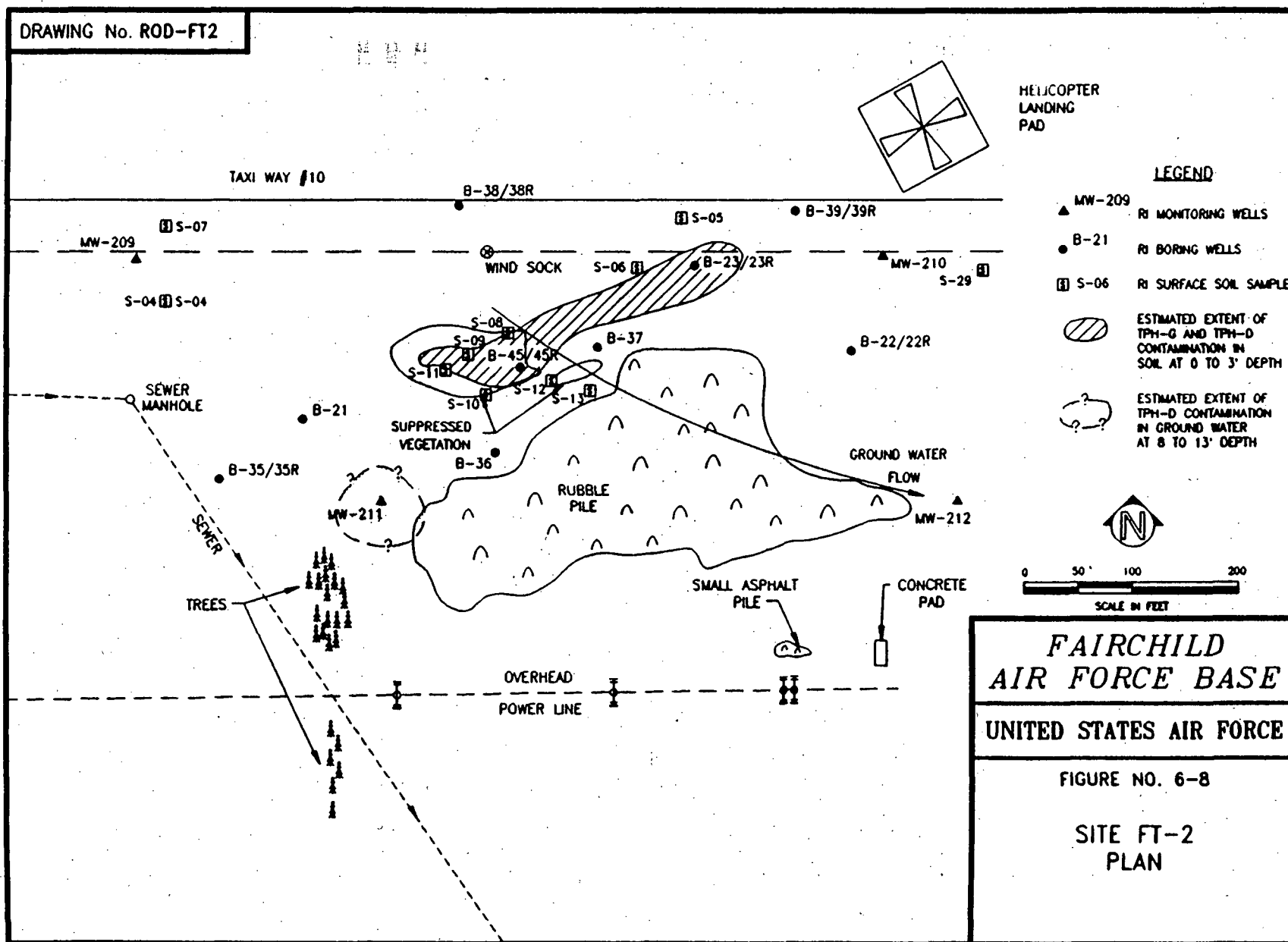
6.8.2.1 Subsurface Soils. Eight soil borings, B-21 through B-23 and B-35 through B-39, were installed in March 1993. Six additional borings (B-22R, B-23R, B-35R, B-38R, B-39R and B-45R) were drilled in October 1993.

A variety of BTEX and refined fuel residues were detected in soil borings at the site. These residues included n-butylbenzene, sec-butylbenzene, p-cymene, 2-methylnaphthalene, n-propylbenzene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. Chlorinated hydrocarbons including methylene chloride, TCE, 1,1-dichloroethane, cis-1,2-dichloroethene, and pentachlorophenol. These compounds were attributed to flammable materials used for fire training exercises. Maximum concentrations of these compounds were detected in soils within and near the suppressed vegetation zones.

SVOC associated with fuel residues were detected in B-45R soils. These included 3,4-methylphenol, naphthalene, and 2-methylnaphthalene. This boring lies in the center of the largest suppressed vegetation zone.

In several borings, metals were detected at concentrations greater than site natural background levels. With the exception of vanadium, a fuel oil additive, metals above site natural background levels are mostly near the soil surface. The predominance of metals in surface soil is a result of historic activities which have littered the site with a variety of metallic debris. Metals attributed to this debris include aluminum, barium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, molybdenum, and zinc.

Fuel residues are the largest contaminant source in subsurface soils at FT-2, and the largest source for ground water contamination. Petroleum and fuel residues were measured in B-23, B-36, B-37, and B-45R. Concentrations are highest in B-45R in the center of a suppressed vegetation zone where a maximum concentration of 4,500 mg/kg was observed. Figure 6-8 shows extents of remaining petroleum contamination in soil at the site. The width of this contaminated zone is also defined by surface expression of fuel residues described in the next section.



6.8.2.2 Surface Soils. Ten surface soil samples were collected at FT-2, six within the suppressed vegetation zone (S-08, S-09, S-10, S-11, S-12, and S-13) and four from the surrounding area (S-04, S-05, S-06, and S-07). Several VOC were detected at low concentrations at each location. Compounds detected included BTEX and refined fuel residues seen elsewhere at FT-2. Chlorinated hydrocarbons detected included methylene chloride, 1,2-dichlorobenzene, and 1,2-dichloroethane.

Pentachlorophenol, the only SVOC detected, was present in S-11 at a concentration of 1.28 mg/kg. One of its known uses is as a wood preservative. Its source is unknown; however, this chemical, like the VOCs found at the site, may be present in some flammable materials used for fire training exercises.

Fuel residues were present above regulatory levels in several surface soil samples concentrations ranging from 472 mg/kg to 5,398 mg/kg. These detections all occurred within the suppressed vegetation zones.

Metals with concentrations above site natural background levels were detected in all surface samples except sample S-07 and background samples S-27, S-28, S-29, and S-30. Specific metals include aluminum, cadmium, chromium, copper, lead, nickel, silver, and zinc. Their presence is attributed to old airplane parts that litter FT-2. No vanadium was detected above natural background levels in surface soils, indicating this metal is associated with the subsurface fuel residue contamination. Maximum metal concentrations are in the suppressed vegetation zones. Concentrations in surface soils decrease outside this zone.

Analysis of samples by particle size showed metals contamination preferentially adheres to fine grained sediment particles less than 53 μm in diameter. Metals of concern which show the strongest tendency to adhere to this potentially respirable sediment fraction include cadmium, chromium, copper, lead, and zinc.

6.8.2.3 Ground Water. The Air Force installed four monitoring wells, MW-208, MW-209, MW-210, and MW-211, during remedial investigation activities. Most contaminants found in ground water from these wells were attributed to flammable materials used for fire training exercises. These materials include petroleum products derived from leaded aviation gas, jet fuel, and chlorinated solvents found in flammable materials. Carbon tetrachloride was detected in MW-209 during three separate sampling events and at low concentrations (under 2 $\mu\text{g/L}$). Its presence in this up gradient well indicates this contamination is from another source west of FT-2.

Contaminants detected in well MW-211 were dimethylphthalate (20 $\mu\text{g/L}$) (a plasticizer used in resins and lacquers) and petroleum fuel residues (22,000 $\mu\text{g/L}$). This petroleum value could not be verified, however, due to missing analytical laboratory data.

Several solvent and fuel related VOCs were detected in downgradient wells MW-210 and MW-212 during all sampling events. VOCs detected included sec-butylbenzene, 1,1-dichloroethylene, 1,1-dichloroethane, and cis-1,2-dichloroethylene. Concentrations were close to the 2.0 µg/L detection limit for all compounds except cis-1,2-dichloroethylene, which ranged from 6.0 µg/L to 31 µg/L.

Dissolved metals were detected above natural background levels in the two downgradient wells, MW-210 and MW-212. Manganese, iron, lead, and nickel were reported in MW-210 ground water, and silver and zinc were detected in MW-212 ground water. Manganese concentrations ranged from 1.84 mg/L to 2.39 mg/L, well above the natural background level of 0.11 mg/L. The other metals were found at concentrations close to natural background levels.

6.8.3 Summary of Site Risks

Likely exposure scenarios to contaminants in FT-2 soil and ground water include inhalation of dust, ingestion of soils or ground water, and inhalation of volatiles in ground water.

There are no permanent surface water features at FT-2. Runoff from the site can occur during periods of rainfall or snow melt; however, relatively flat topography and vegetation of the site serve to maximize infiltration and minimize runoff. Any runoff from the site would be expected to flow southeast toward the Weapon Storage Area.

The potential exists for release of contaminants into air if contaminated soils are disturbed. Most of the year, the prevailing wind is from the southwest with an average annual wind speed of 6 to 10 miles per hour. During the winter months wind is typically from the east-northeast. Calm conditions occur approximately 20% of the year. Maximum exposure to fugitive dust from FT-2 is expected to occur in adjacent unoccupied grassy areas located down wind.

Soil contaminants that leach to ground water migrate eastward as indicated by detections of metals and some VOC in downgradient wells. However, ground water at FT-2 is not currently used as a water supply source so current ground water exposure scenarios were not evaluated.

Access to the site is currently limited to Air Force personnel and contractors. There are no residential areas adjacent to FT-2 and no other attraction that might induce trespassers or visitors to the site. Therefore, Air Force personnel and contractors are the only receptor group that were evaluated for the current use scenario. However, exposures for hypothetical future residents were also evaluated.

6.8.3.1 Contaminants of Concern. Three metals and nine organic compounds were retained as potential contaminants of concern in soils. Cobalt exceeded the natural background levels, copper exceeded the risk screening level for noncancer effects, and lead exceeded natural background levels. Cobalt and lead do not, however, have toxicity values with which to estimate noncancer hazard or cancer risk. Copper was retained as a contaminant of concern. Of the organic compounds, eight were considered potential contaminants of concern based on the lack of state cleanup levels, risk screening levels, and natural background levels. The noncancer

hazard and cancer risk cannot be quantified for these chemicals. Pentachlorophenol, however, was measured at a maximum concentration that exceeded the risk screening level based on carcinogenicity, therefore it was evaluated as a contaminant of concern.

One metal, three organic compounds, and petroleum were retained as potential contaminants of concern in ground water. Manganese was present at a maximum concentration that exceeded both the state cleanup level and the risk screening level for noncancer effects as well as its natural background levels. Carbon tetrachloride and 1,1-dichloroethylene exceeded both their Method B cleanup levels and risk screening levels for carcinogenicity. These three chemicals were carried through the risk assessment as contaminants of concern. Sec-butylbenzene was identified based on the lack of screening concentration levels. Although toxicity parameters do not exist for petroleum, it was included as a potential contaminant of concern and was evaluated for noncancer hazard.

6.8.3.2 Human Health Risk Assessment. For site FT-2, current risk, based on RME assumptions, under the Air Force Personnel/Contractor scenario is principally due to ingestion of 1,1-dichloroethene and carbon tetrachloride contaminated ground water and rounds up to 2×10^{-6} . Current hazard under the same scenario is principally due to ingestion of manganese contaminated ground water and rounds up to 4. Risk associated with ingestion of ground water is within the acceptable range, while hazard associated with ingestion of ground water exceeds acceptable levels. At present, the ground water pathway is not complete and may never be given the adequacy of the base water supply system. Calculable site values for risk and hazard related to soil are due to ingestion of contaminated soil and amount to 1×10^{-8} for risk and 1×10^{-3} for hazard. Risk and hazard associated with ingestion of soil are below screening thresholds. Risk associated with petroleum contamination can not be quantified.

6.8.3.3 Ecological Risk Assessment. There is no unacceptable ecological risk from contaminants of concern to target species at Site FT-2.

6.8.4 Conclusions

There is no unacceptable calculable risk or hazard associated with FT-2 soil. Petroleum levels exceeded the state cleanup standard for soils, and contaminated soils could potentially serve as a source of ground water contamination. For these reasons, soil cleanup alternatives were evaluated.

There is no unacceptable calculable risk associated with FT-2 ground water. Manganese contamination in ground water yields a hazard index of 4, but is expected to decrease in parallel with petroleum degradation. Petroleum concentrations in ground water currently exceed the state cleanup level of 1,000 $\mu\text{g/L}$. For this reason, ground water cleanup alternatives were evaluated.

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7.0 REMEDIAL ACTION OBJECTIVES

During the RI contaminants were identified and retained as contaminants of concern for each Priority 2a site subject to the LFI. Potential contaminants of concern were selected based on their RBSLs ($HQ > 0.1$ or risk $> 1 \times 10^{-7}$ for soil and $HQ > 1$ or risk $> 1 \times 10^{-6}$ for ground water) and whether their maximum concentrations exceed MTCA Methods A or B, MCLs, or high normal background concentrations. When the risk assessment was completed preliminary contaminants of concern were selected based on the contaminants exceeding HQ of 1, and risk exceeding 1×10^{-6} , and whether their maximum concentrations exceed MTCA Method B or Method A limits, or MCLs. Finally, to establish final contaminants of concern, EPA, Ecology, and the Air Force conducted a risk management screening on preliminary contaminants of concern. A complete discussion of risk management decisions made for Priority 2a sites is presented in Appendix C.

Remedial Action Objectives (RAOs) are established to protect human health, public welfare, and the environment from potential hazards posed by final contaminants of concern at any given site. The RAOs for a given media are the same for all Priority 2a sites.

Remedial Action Objectives for Ground Water (Applicable to Sites PS-1, PS-5, PS-7, and FT-2):

- To prevent ingestion, inhalation, and dermal contact with final ground water contaminants of concern on-site or off-site with cancer risk in excess of 1×10^{-6} or non-cancer HQ of 1, or concentrations in excess of MCLs or MTCA cleanup levels.
- To remediate contaminated ground water to a safe level for off-site human consumption.
- To prevent migration of contaminated ground water above cleanup levels into uncontaminated zones.

Remedial Action Objectives for Soils (Applicable to Sites IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2):

- To prevent ingestion, inhalation of dusts and airborne contaminated particles, and dermal contact with final soil contaminants of concern on-site or off-site with cancer risk in excess of 1×10^{-6} or non-cancer hazard of 1, or concentrations in excess of MTCA cleanup levels.
- To remediate contaminated soil to a level that is protective of human health and the environment.
- To prevent migration of final contaminants of concern to ground water.

7.1 DEVELOPMENT OF CLEANUP LEVELS

Site IS-3: The results of the risk assessment indicate there would be no unacceptable risks to human health posed by exposure to the water or sediments in the sump. However, because the sediments contain PCBs above the MTCA Method B soil cleanup level of 0.13 mg/Kg, and because some uncertainty remains about the possibility of past releases of contaminants from the sump into the surrounding soils, the Air force is planning to remove the remaining water and sediment from the sump. In addition, when the building is demolished, the Air Force will analyze soils surrounding the sump for PCB contamination. If contamination is found, the affected soils will be treated or disposed of in accordance with all applicable federal, state, and local regulations.

Sites IS-4, PS-1, PS-5, PS-7, and FT-2: The results of the risk assessment indicate that there would be no unacceptable risks to human health posed by exposure to the final soil contaminants of concern at these sites. However, soils contaminated with petroleum which could serve as a source of ground water contamination remain at IS-4. Additionally, petroleum is present at Sites PS-1, PS-5, PS-7 and FT-2 in both soil and ground water at concentrations that exceed the MTCA Method A cleanup level of 200 mg/Kg. At site PS-1, benzene was found in ground water at levels above the MCL of 5 µg/L, and with cancer risk of 1×10^{-4} .

The following cleanup levels have been selected for cleanup actions at Sites IS-4, PS-1, PS-5, PS-7, and FT-2:

- The cleanup level for petroleum contaminated soil at Sites IS-4, PS-1, PS-5, PS-7, and FT-2, based on MTCA Method A, is 200 mg/Kg.
- The cleanup level for petroleum contaminated ground water at Sites PS-1, PS-5, PS-7, and FT-2, based on MTCA Method A, is 1,000 µg/L.
- The cleanup level for benzene contaminated ground water at Site PS-1, based on MCLs, is 5 µg/L.

Site PS-10: The results of the risk assessment indicate there is a cancer risk of 1×10^{-5} due to TCE-contaminated soil at the site. Also, soil contaminated with petroleum is present at the site and could serve as a source of ground water contamination.

- The following cleanup levels have been selected for cleanup action at Site PS-10:
- The cleanup level for petroleum contaminated soil at Site PS-10, based on MTCA Method A, is 200 mg/Kg.
- The cleanup level for TCE contaminated soil at Site PS-10, based on MTCA Method B, is 91 mg/Kg.

Site SW-11: Because the Air Force considers the buried debris at this site a physical and not a chemical hazard, a risk assessment for chemical exposures was not performed. Although some contaminants were detected at the site at concentrations above their cleanup levels, they are in the form of metal aircraft parts and fragments found in the soil, and don't represent a chemical threat to human health or the environment. Consequently, no cleanup action objectives have been established for Site SW-11, and it is not discussed further in the proposed plan.

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8.0 SUMMARY OF ALTERNATIVES

A range of cleanup alternatives was initially identified in the feasibility study. These alternatives were evaluated based on effectiveness, implementability, and cost. Based on the initial screening, the most promising alternatives were developed into site-specific final alternatives that were then subjected to a detailed analysis. The following is a list of the nine criteria for evaluating cleanup alternatives. These criteria are discussed in greater detail in Section 9.0.

- Overall Protection of Human Health and Environment;
- Compliance with State and Federal Regulations;
- Long-term Effectiveness and Permanence;
- Reduction of Toxicity, Mobility, or Volume Through Treatment;
- Short-term Effectiveness;
- Implementability;
- Cost (Net Present Value);
- State Acceptance; and
- Community Acceptance.

8.1 NO ACTION

The "No Action" alternative was considered for ground water at PS-1, PS-5, PS-7, and FT-2. This alternative was considered for soil at IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2.

The NCP requires the "No Action" alternative be evaluated at every site to establish a baseline for comparison. This alternative involves conducting no further actions at the site. In the case of petroleum contamination, natural microbial biodegradation or physical weathering is expected to occur. Eventually the concentration of petroleum hydrocarbon contamination may reduce to the point where state or federal based remedial action objectives are achieved.

8.2 INSTITUTIONAL CONTROLS AND MONITORING

Institutional controls and monitoring was considered for ground water at PS-1, PS-5, PS-7, and FT-2. This alternative was considered for soil at IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2.

Institutional controls are non-engineering remedial mechanisms that may be used to prevent exposure to contaminants remaining at hazardous waste sites at concentrations above health-risk levels. Section 300.430 of the NCP states that institutional controls (1) may be used to supplement engineering controls as appropriate to prevent or limit exposure to contaminated sites, (2) may be used during the conduct of the RI/FS or implementation of a response action

and, where necessary, as a component of a final remedy, and (3) should not be substituted for active response measures as the sole remedy unless such measures are determined not to be practicable. While institutional controls will typically be used in conjunction with engineering controls as part of a remedial action, they may be the only means available to achieve protection of human health and the environment.

At Fairchild AFB, there are two principal institutional control mechanisms through which personnel are protected from contamination. These include Work Clearance Permits, and base planning (both in civilian administrative processes as well as military administrative processes).

The first mechanism to preserve the safety of personnel with respect to contamination is the Work Clearance Permit. No digging below two inches can be undertaken without a Work Clearance Permit, and the Work Clearance Permit triggers several other review processes which include base civil engineering and environmental review. The Work Clearance Permit also prevents the installation of any new wells without the review process. This review process includes the following activities:

- 1) The Air Force has implemented Instruction 32-1031, which Fairchild AFB complied with by issuing Regulation 85-1. Regulation 85-1 requires all base personnel and contractors to complete a Work Clearance Permit (Air Force Form 103) to gain authorization to commence any activity which results in uncovering earth below two inches.
- 2) The permitting process requires the permittee to first review utility maps and then proceed to gain clearance from several base engineering groups (such as Base Communications, Electrical Shop, Cathodic Protection, the Fire Department, Underground Cable, and several other departments) including the Environmental Flight. The Environmental Flight would alert the permittee of any potential environmental hazards. In addition, the permittee is required to review maps obtained from the Drafting Element. Sites with environmental hazards are plotted on these maps. In this manner, the permittee has a two fold notice of the potential for hazardous environmental conditions on any given site.

The second mechanism is administrative instruments within the base planning process. These are typically referred to as Base Comprehensive Plans or Base Master Plans. At Fairchild, the particular instrument that will directly oversee these IRP sites is the Fairchild Air Force Base Commander's Summary. This plan details the base's long-range, comprehensive approach to directing its evolution and solving facility and community needs. It sets forth solutions and priorities for development of the Fairchild community and protection of the Fairchild neighborhood through establishing various development constraints. Development constraints include building constraints and environmental constraints, both of which include environmental aspects. Building constraints include protective allowances for historical sites, noise regulation, and establishment of safety zones. Environmental constraints specifically control development around IRP sites, landfills, and potential wetlands. The Base Commander's Summary serves a

function similar to land use planning and zoning activities in civilian communities, and contains controls specifically designed to prevent development or community interaction with IRP sites until after remedial actions are completed.

In the event of base closure, future use activities are protected at military bases through civilian administrative processes and base planning instruments. Civilian administrative processes designed to ensure protection of human health and the environment include conformance with the National Environmental Policy Act (NEPA). For example, development projects are required to go through the NEPA process. An environmental impact statement is required for significant projects (an environmental assessment for smaller projects) and identifies historical use and potential contamination related to the site proposed for development. In real estate transactions owners are required to reveal any known or potential environmental contamination related to the site. Thus outside of the base planning process, there are administrative processes which assist in protecting the public from exposure to contamination.

If the base should be closed in the future, the need for additional characterization and remedial action to address site-related contamination will be reevaluated by the Air Force, EPA, and Ecology in conjunction with the Community Environmental Response Facilitation Act. The Air Force, EPA, and Ecology may consider deed restrictions precluding the site from residential or agricultural uses. If deed restrictions were determined to be necessary, they would be implemented prior to transfer of the site property to any other entities.

Monitoring is incorporated with institutional controls as a mechanism to observe the decrease in contamination over time and to detect evidence of migration. It is incorporated at all sites where environmental media are known to have been contaminated; where there is risk that the contamination may migrate; and where the contamination is reasonably accessible. For sites presented in this ROD, monitoring is not conducted in conjunction with institutional controls in three instances: for soils and ground water at IS-3, and for soils only at PS-5 and PS-7. At IS-3 no contamination is definitively known to have been released from the sump, the soil and ground water near the sump is difficult to access, and the Air Force plans to demolish the building in the future and will further investigate the sump environment when the building structures and flooring are removed. At sites PS-5 and PS-7 the soil contamination is buried beneath several feet of clean fill or under asphalt paving or building related structures and therefore poses no risk at the surface. The subsurface vadose zone contamination is not expected to migrate. The ground water will be monitored at PS-5 and PS-7, detecting any impact the vadose contamination may have upon the ground water.

Soil and ground water monitoring will be conducted in a phased manner starting on a semiannual basis. In conjunction with historic data, if a clear decline in contamination can be demonstrated, and that decline is consistent with current projections, sampling may be reduced to annual, biannual and eventually longer terms as negotiated at that time by the Air Force, EPA, and Ecology.

In the case that subsequent monitoring determines contamination to be migrating or increasing the potential for harm to human health or the environment, the site will be reassessed. The remedies for contamination at these sites are based on the physical conditions identified through

the LFI and subsequent RI process. The subsequent remedial action analyses conducted in the FS were based on those findings. Should those findings prove to have been in error, and monitoring determines the contamination is in fact moving in a manner that threatens human health and the environment, the site will be reevaluated, and if warranted, additional characterization will be conducted at the site, and the remedies reassessed.

This alternative involves no active treatment of contaminated media. Remediation of petroleum related compounds would occur through natural attenuation, primarily microbial biodegradation, along with volatilization, dispersion, and physical weathering. Chlorinated organic solvents, such as TCE, can biodegrade under certain circumstances, but little short term reduction is expected.

This alternative is considered because of the relatively low cancer risk and noncancer hazard posed by many of the sites. Biodegradation of petroleum hydrocarbons occurs naturally where microbial populations and beneficial conditions (e.g. water, oxygen, temperature, nutrients) are present, but usually takes longer to reach state, federal, or risk based cleanup levels than more aggressive remedial actions. Monitoring would be conducted to confirm that passive biodegradation is occurring and the contaminants of concern are not migrating offsite.

8.2.1 Sites IS-4, PS-10, and FT-2

Because these sites are adjacent to the flightline access is limited to authorized contractors and Air Force personnel. Institutional controls include requiring a Work Clearance Permit before proceeding with intrusive activities. Personnel conducting intrusive activities would be warned about site conditions and would be required to take appropriate health and safety precautions to avoid exposure to contaminants. Due to their locations, it is unlikely that residents would have any reason to access these sites. Ground water sampling at FT-2 and soil sampling at IS-4, PS-10, and FT-2 would monitor contaminant degradation and migration. Institutional controls would be kept in place until cleanup levels are achieved, therefore protecting against human exposure to contaminants.

8.2.2 Site PS-1

This site is accessible to Base personnel. Institutional controls include requiring a Work Clearance Permit before proceeding with intrusive activities. Personnel conducting intrusive activities would be warned about site conditions and would be required to take appropriate health and safety precautions to avoid exposure to contaminants. Soil and ground water sampling would monitor contaminant degradation and migration. Institutional controls would be kept in place until cleanup levels are achieved, therefore protecting against human exposure to contaminants.

8.2.3 Sites PS-5 and PS-7

While both of these sites are readily accessible to base personnel, removal actions at these sites have extracted near surface contaminated soil and replaced it with clean fill. Remaining contamination lies several feet beneath the surface at these sites and poses no health risk to persons at the surface. Institutional controls would be initiated requiring a Work Clearance

Permit before proceeding with intrusive activities at these sites. Personnel conducting intrusive activities would be warned about site conditions and would be required to take appropriate health and safety precautions to avoid exposure to contaminants. Ground water sampling would monitor contaminant biodegradation and any tendency for migration at both sites. Institutional controls would be kept in place until cleanup levels are achieved, therefore protecting against human exposure to contaminants. Soil monitoring at these sites is unnecessary. The cleanup level for petroleum contaminated soil is based on protection of ground water. Ground water monitoring at these sites will assess if there is any petroleum migration from the soil.

8.3 BIOVENTING

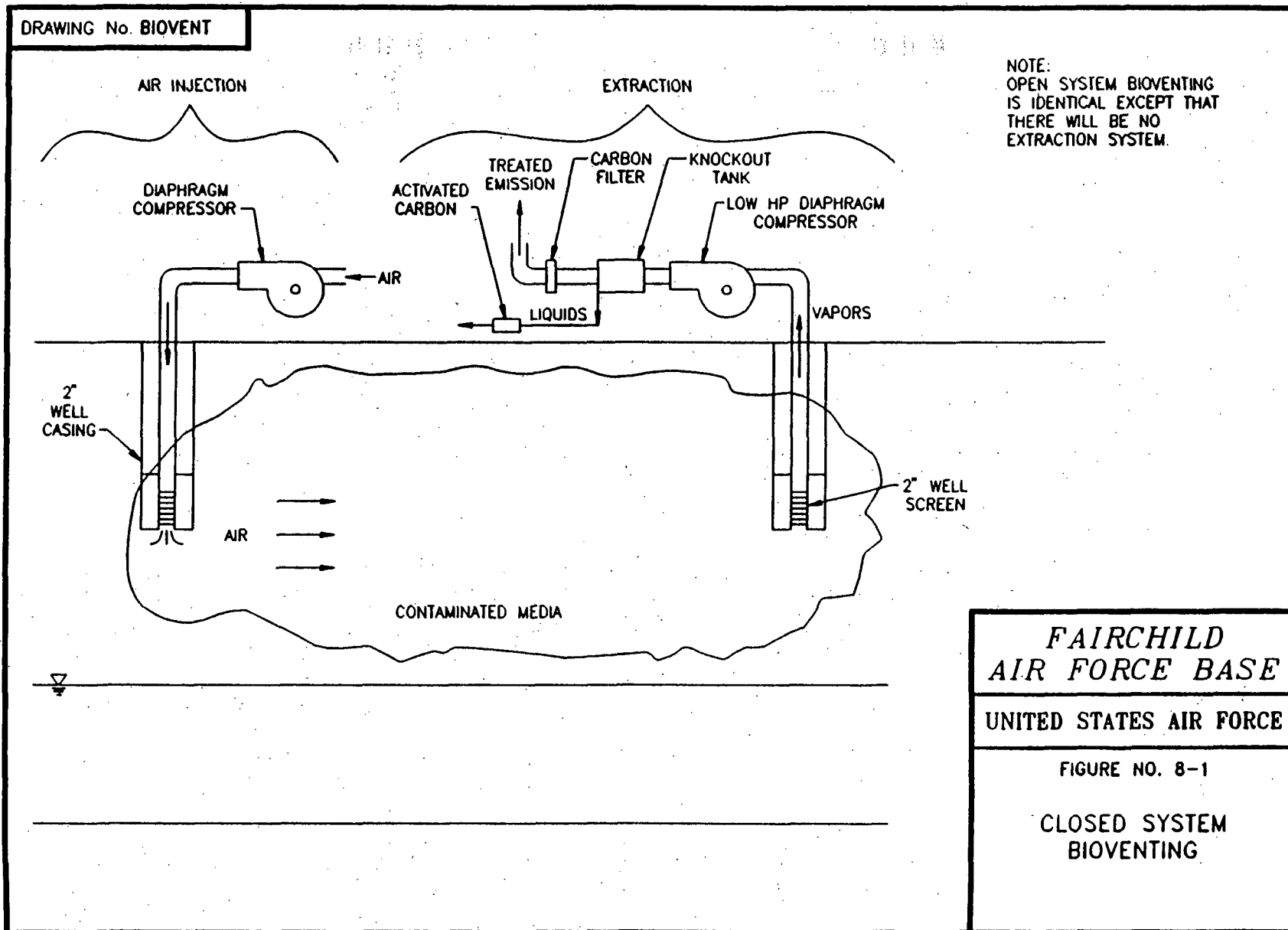
Bioventing was considered for soil at IS-4, PS-1, PS-5, PS-7, and FT-2.

Bioventing is an innovative method for promoting in place bioremediation of organic contamination in soil (principally petroleum hydrocarbons). Bioventing is an effective, unobtrusive, low maintenance alternative for remediating petroleum hydrocarbons to meet cleanup goals. It has been extensively tested, but is still considered innovative. The Air Force has developed considerable expertise in this technology and has initiated a pilot bioventing project at PS-1. Initial results from the PS-1 pilot project indicate open system bioventing will increase the oxygen content and biodegradation activity in site soil.

It can be accomplished using either a closed or an open system. Open system bioventing consists of a series of vents through which air is injected without extraction. The benefits of this system include an increased residence time of oxygen (which enhances natural biodegradation) and the absence of extracted air to treat. Disadvantages are uncertainty in distribution, and the potential for moving soil vapors into buildings. Open system bioventing would be applied to sites located away from buildings.

Closed system bioventing includes a network of injection and extraction vents to gain greater control over the flow of injected air. The disadvantage of this system is the need to manage contaminant vapor emissions. If operated properly, the rate of air flow should not generate organic vapors after biodegradation has begun. Closed system bioventing is applied to sites located near buildings. If an active system is not in place to remove injected air from the soil, the air could migrate into basements. This could lead to a dangerous situation if the air contains a high concentration of VOCs. Figure 8-1 shows a schematic diagram of a closed system bioventing design.

Before full scale implementation at sites other than PS-1, the effectiveness of bioventing would be tested using a pilot scale system. A soil monitoring program would be implemented to evaluate the effectiveness of the system and to assess contaminant migration. During cleanup, institutional controls would be maintained to prevent human exposure to contamination.



8.3.1 Sites IS-4, PS-1, and FT-2

These sites are suitable for open system bioventing. Contaminants of concern at these sites include biodegradable petroleum residues. Buildings are located far enough away from contaminant plumes so that soil vapor migration is not a problem. The system would be operated until soil cleanup levels are achieved, therefore protecting ground water from further contamination.

8.3.2 Sites PS-5 and PS-7

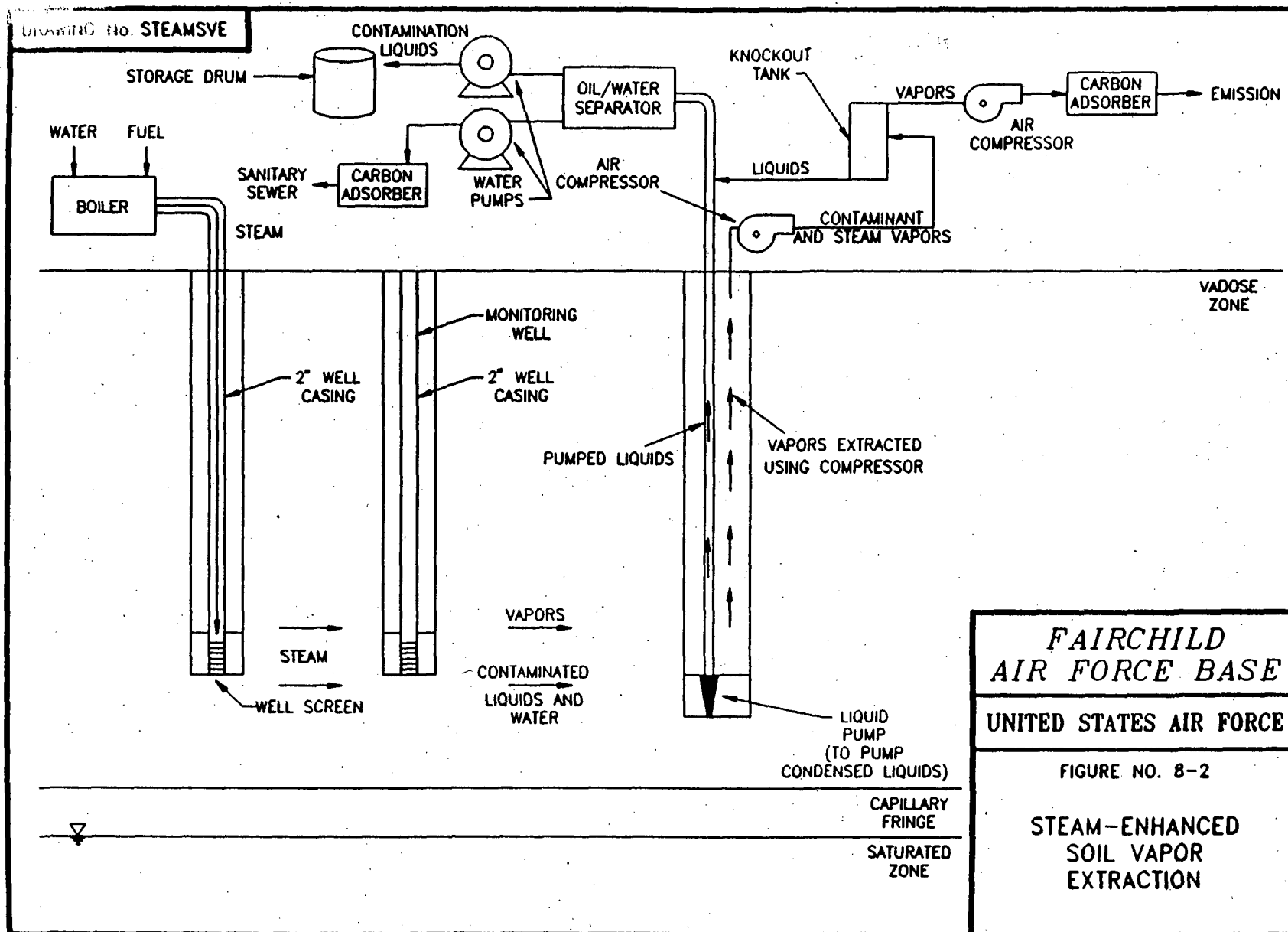
These sites are candidates for closed system bioventing. Biodegradable petroleum residues are the only contaminants of concern at these sites. In order to prevent the migration of soil vapors into occupied buildings, vapor extraction wells would be installed. Soil vapor would be treated to remove hazardous components and to comply with Washington State and Spokane County air standards before being released to the atmosphere. The system would be operated until soil cleanup levels are achieved, therefore protecting ground water from further contamination.

8.4 STEAM-ENHANCED SOIL VAPOR EXTRACTION

Steam-enhanced soil vapor extraction was considered for soil at IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2.

Steam-enhanced soil vapor extraction involves injection of steam into soils to facilitate volatilization of organics. Volatilized organic vapors are vacuum extracted from the soil and treated. In place physical removal methods, such as soil vapor extraction, would not be successful at removing diesel range petroleum fractions because the majority of its constituents have low volatilities at ambient temperatures. Enhancing traditional soil vapor extraction by injecting steam into the vadose zone would result in volatilizing these otherwise low volatility constituents so that they can be vacuum extracted from the soil. This technology also works well with chlorinated solvents such as TCE and more volatile petroleum hydrocarbons such as gasoline or other light fuels. The system would be operated until soil cleanup levels are achieved, therefore protecting ground water from further contamination. Figure 8-2 shows a schematic diagram of a steam-enhanced soil vapor extraction system.

Before full scale implementation, the effectiveness of steam-enhanced soil vapor extraction would be tested using a pilot scale system. A soil monitoring program would be implemented to evaluate the effectiveness of the system and to assess contaminant migration. During cleanup, institutional controls would be maintained to prevent human exposure to contamination.



8.5 SOIL VAPOR EXTRACTION

Soil vapor extraction was considered for soil at PS-10.

Soil vapor extraction is an EPA presumptive remedy for removing VOCs from soils. This method works by essentially vacuuming contaminant vapor from the soil. The VOCs present in the soil are volatilized, and extracted from the soil through a system of vents. This technique is not effective at extracting low volatility fractions of diesel fuel or jet fuel. Soil vapor extraction does, however, help to oxygenate soils which facilitates biodegradation of petroleum residues. Implementing a soil vapor extraction program at PS-10 would reduce TCE contamination to below state cleanup levels. Increased aerobic biodegradation brought about by a soil vapor extraction system may not reduce petroleum concentrations to below state cleanup standards, therefore, this alternative would probably be coupled with an approach directed at the petroleum residues. The system would be operated until soil cleanup levels are achieved, therefore protecting ground water from further contamination.

Before full scale implementation, the effectiveness of soil vapor extraction would be tested using a pilot scale system. A soil monitoring program would be implemented to evaluate the effectiveness of the system and to assess contaminant migration. During cleanup, institutional controls would be maintained to prevent human exposure to contamination.

8.6 EXCAVATION AND SOIL WASHING

Excavation and soil washing was considered for soil at IS-4, PS-1, PS-10, and FT-2.

This alternative involves excavation of soils, followed by a wash process. For petroleum derived contaminants, removal can be accomplished by steam washing. The excavated area would be backfilled with the washed soil or other clean soil and graded and seeded to prevent erosion. Since all contaminated soil is removed from the site, ground water is protected from contamination.

8.6.1 Site IS-4

Approximately 1800 cubic yards of petroleum contaminated soil would be removed and washed.

8.6.2 Site PS-1

Approximately 16,000 cubic yards of petroleum contaminated soil would be removed and washed. PS-1 is an active bulk fuel storage terminal, therefore coordinating excavation activities and fuel handling operations would require careful planning. Excavation of soil beneath the fuel tanks is impossible.

8.6.3 Site PS-10

Approximately 600 cubic yards of petroleum contaminated soil would be removed and washed. Approximately 67 cubic yards of TCE contaminated soil would be excavated, washed, and landfilled. In order to meet Land Disposal Restrictions (LDRs), TCE contamination must be reduced to 6.0 mg/kg before landfilling. Soil washing is capable of meeting that requirement but incineration is the Best Demonstrated Available Technology (BDAT) for TCE contaminated.

8.6.4 Site FT-2

Approximately 5,600 cubic yards of petroleum contaminated soil would be removed and washed.

8.7 EXCAVATION AND OFFSITE DISPOSAL

Excavation and offsite disposal was considered for soil at IS-4, PS-1, PS-10, and FT-2.

This alternative involves soil excavation, followed by transport of the contaminated soil to an approved landfill (such as a Class I Subtitle C landfill). The excavated area would be backfilled with clean soil and graded and seeded to prevent erosion. Since all contaminated soil is removed from the site, ground water is protected from contamination.

8.7.1 Site IS-4

Approximately 1800 cubic yards of petroleum contaminated soil would be removed and landfilled.

8.7.2 Site PS-1

Approximately 16,000 cubic yards of petroleum contaminated soil would be removed and landfilled. Since PS-1 is an active bulk fuel storage terminal, coordinating excavation activities and fuel handling operations would require careful planning. Excavation of soil beneath the fuel tanks is impossible.

8.7.3 Site PS-10

Approximately 600 cubic yards of petroleum contaminated soil would be removed and landfilled. Approximately 67 cubic yards of TCE contaminated soil would be excavated, incinerated, and landfilled. In order to meet LDRs, TCE contamination must be reduced to 6.0 mg/kg before landfilling. Incineration is capable of meeting that requirement and is the BDAT for TCE contaminated soil.

8.7.4 Site FT-2

Approximately 5,600 cubic yards of petroleum contaminated soil would be removed and landfilled.

8.8 EXCAVATION AND LOW TEMPERATURE THERMAL DESORPTION

Excavation and low temperature thermal desorption was considered for soil at IS-4, PS-1, PS-5, PS-7, PS-10, and FT-2.

This alternative involves soil excavation and heating of the soil to volatilize organic contaminants. Resultant gasses are captured and treated. The excavated area would be backfilled with clean soil and graded and seeded to prevent erosion. Thermal desorption is an EPA presumptive remedy for removing VOCs from soils and is also effective on petroleum contamination. Since all contaminated soil is removed from the site, ground water is protected from contamination.

Thermal desorption vendors have various recycling uses for treated soils, including use as fill and cement makeup material.

8.8.1 Site IS-4

Approximately 1800 cubic yards of petroleum contaminated soil would be removed and thermally desorbed.

8.8.2 Site PS-1

Approximately 16,000 cubic yards of petroleum contaminated soil would be removed and thermally desorbed. Since PS-1 is an active bulk fuel storage terminal, coordinating excavation activities and fuel handling operations would require careful planning. Excavation of soil beneath the fuel tanks is impossible.

8.8.3 Site PS-5

Approximately 185 cubic yards of petroleum contaminated soil would be removed and thermally desorbed. Since contaminated soil lies in a thin horizontal layer 10 feet beneath the surface, approximately 1,850 cubic yards of overburden would have to be excavated to access the contaminated soil.

8.8.4 Site PS-7

Approximately 60 cubic yards of petroleum contaminated soil would be removed and thermally desorbed. About half the contaminated soil lies beneath Building 1350, making excavation impractical until Building 1350 is razed.

8.8.5 Site PS-10

Approximately 600 cubic yards of petroleum contaminated soil would be removed and landfilled. Approximately 67 cubic yards of TCE contaminated soil would be excavated, thermally desorbed, and landfilled. In order to meet LDRs, TCE contamination must be reduced to 6.0 mg/kg before landfilling. Thermal desorption is capable of meeting that requirement but incineration is the BDAT for TCE contaminated soil.

8.8.6 Site FT-2

Approximately 5,600 cubic yards of petroleum contaminated soil would be removed and landfilled.

8.9 BIOSPARGING

Biosparging was considered for ground water at PS-1, PS-5, PS-7, and FT-2.

This alternative involves sparging (pumping air) into groundwater, at a rate sufficient to aerate the water to promote biodegradation but not volatilize hydrocarbon vapors. Petroleum compounds, specifically benzene, are readily biodegradable. The moist conditions in the saturated zone support biodegradation. Biosparging provides oxygen which is also necessary for aerobic biodegradation to occur. Figure 8-3 shows a schematic diagram of a biosparging system.

Before full scale implementation, the effectiveness of biosparging would be tested using a pilot scale system. A ground water monitoring program would be implemented to evaluate the effectiveness of the system and to assess contaminant migration. During cleanup, institutional controls would be maintained to prevent human exposure to contamination.

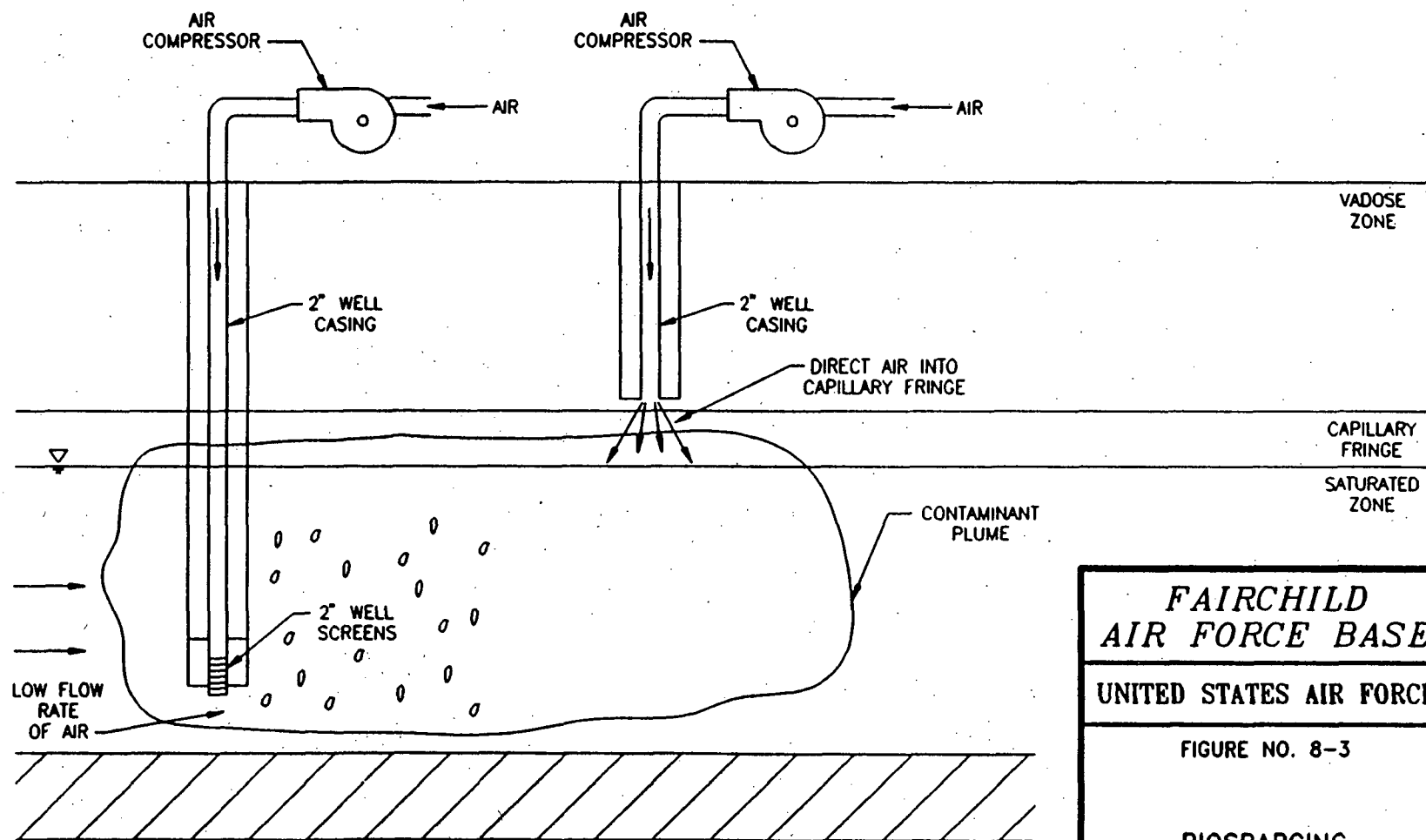
8.10 STEAM INJECTION WITH VAPOR EXTRACTION

Steam injection with vapor extraction was considered for ground water at PS-1, PS-5, PS-7, and FT-2.

This alternative involves injecting steam into the groundwater to vaporize organic contaminants. Vaporized contaminants rise into the unsaturated soil column where organic vapors are vacuum extracted and treated to comply with Washington State and Spokane County air standards. Liquids resulting from the steam may also carry organic contaminants. These are pumped from wells to the surface, and are treated above ground. In place physical removal methods, such as soil vapor extraction, are not successful at removing diesel and higher boiling range petroleum hydrocarbons from saturated zones because the majority of these compounds have low volatilities at ambient temperatures. Enhancing traditional soil vapor extraction by injecting steam into the saturated zone would result in volatilizing these otherwise low volatility constituents and allow them to be removed. The system would be operated until ground water cleanup levels are achieved. Figure 8-4 shows a schematic diagram of a steam injection with vapor extraction system.

Before full scale implementation, the effectiveness of steam injection with vapor extraction would be tested using a pilot scale system. A ground water monitoring program would be implemented to evaluate the effectiveness of the system and assess contaminant migration. During cleanup, institutional controls would be maintained to prevent human exposure to contamination.

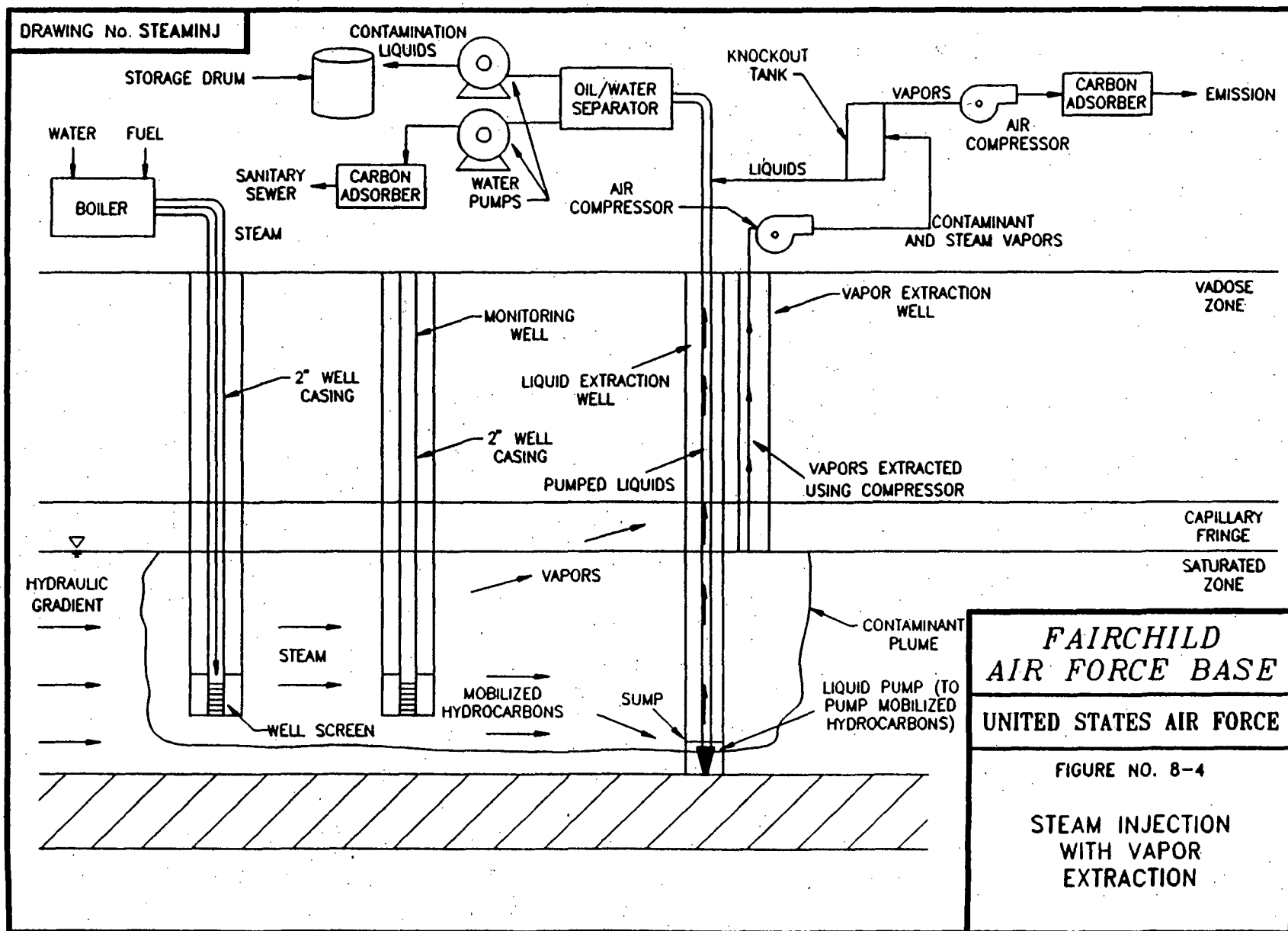
DRAWING No. BIOREM

*FAIRCHILD
AIR FORCE BASE*

UNITED STATES AIR FORCE

FIGURE NO. 8-3

BIOSPARGING

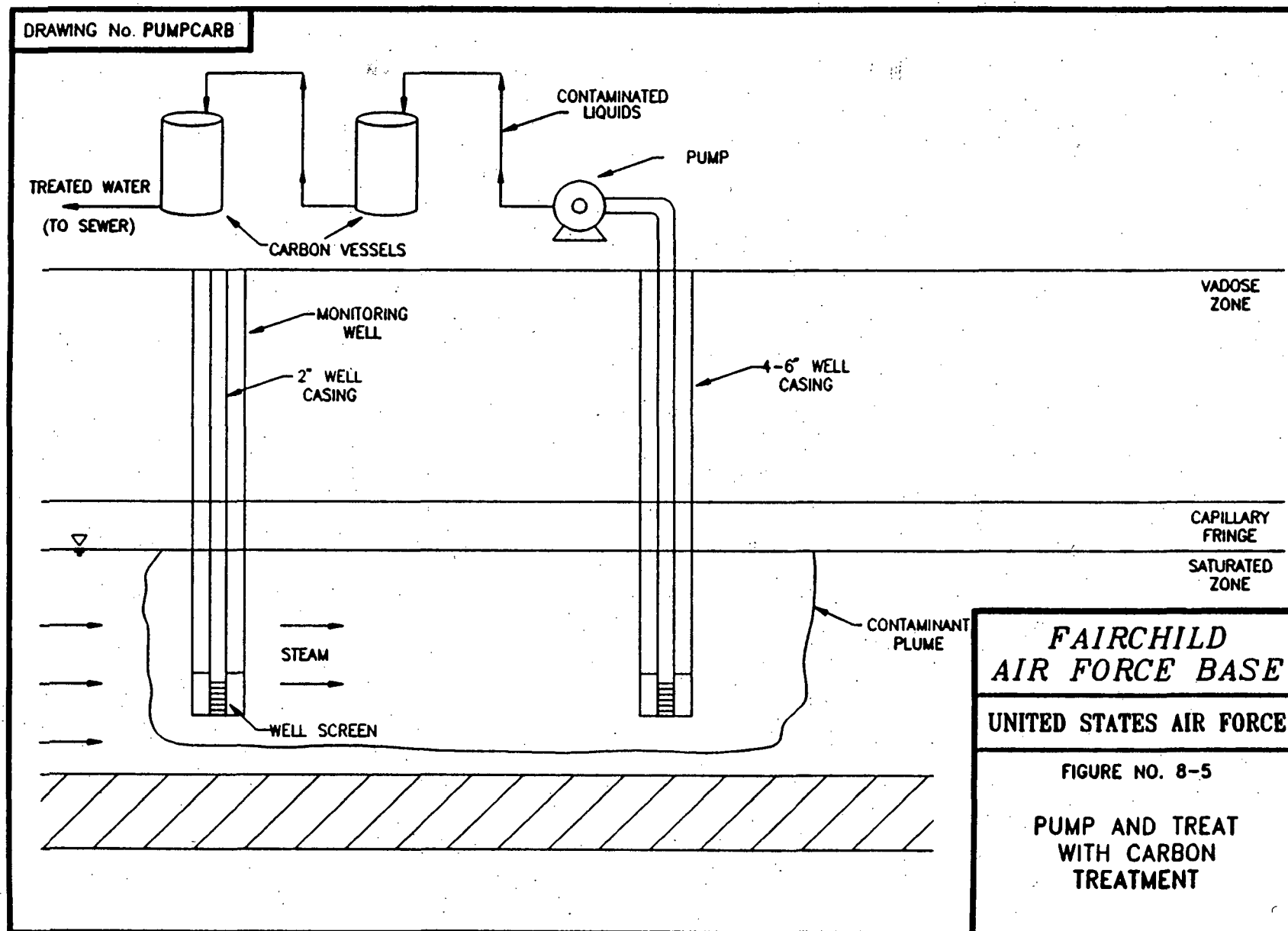


8.11 PUMP AND TREAT WITH TREATMENT USING CARBON ADSORPTION

Pump and treat with treatment using carbon adsorption was considered for ground water at PS-1, PS-5, PS-7, and FT-2.

This alternative involves pumping groundwater then treating the water by passing it through granular activated carbon. As ground water cascades through a bed of carbon, organic contaminants are adsorbed onto the carbon from the water. Use of granular activated carbon as the treatment portion of a ground water pump and treat system, can be considered an EPA presumptive remedy. Granular activated carbon is an established treatment method used in pump and treat systems, and carbon treatment systems are readily available. Once contaminants are brought to the surface, treatment is straight forward. The drawback to pump and treat systems is the uncertainty that all contaminated ground water can be captured and that residual free phase contamination would continue to recontaminate the ground water thus prolonging the remedial action.

Before full scale implementation, the effectiveness of pump and treat using carbon adsorption would be tested using a pilot scale system. A ground water monitoring program would be implemented to evaluate the effectiveness of the system and assess contaminant migration. During cleanup, institutional controls would be maintained to prevent human exposure to contamination. Figure 8-5 shows a schematic diagram of a pump and treat system.



9.0 EVALUATION OF ALTERNATIVES AND THE SELECTED REMEDIES

Alternatives for remediating the Priority 2a sites are evaluated in the "Feasibility Study for Priority 2a sites at Fairchild AFB" (ICF 1995b). Each alternative was evaluated against the nine criteria discussed below. The alternatives were compared to one another to identify the advantages, disadvantages, and relative trade-offs among the alternatives. The complete evaluation is presented in Chapter 6 of the feasibility study. The following sections summarize the evaluation process and present the selected remedies for addressing environmental contamination at each site. Tables 9-1 and 9-2 list remedial alternatives evaluated and the selected remedy(ies) for each site and media.

9.1 EVALUATION CRITERIA

The EPA provide nine criteria to identify the selected remedy for a given site. The criteria are arranged in three categories: Threshold, Primary Balancing, and Modifying criteria. A remedial alternative must first comply with the two threshold criteria in order to be considered further in the remedial alternative selection process. Once an alternative satisfies the threshold criteria, it is evaluated against the five primary balancing criteria. Modifying criteria are used in the final evaluation of the remedial alternatives.

9.1.1 Threshold Criteria

Overall Protection of Human Health and the Environment. This describes whether a cleanup action provides adequate protection and how potential risks are eliminated, reduced, or controlled through treatment or institutional controls, both during and after remediation.

Compliance with Federal and State Regulations. This describes whether a cleanup action will meet all federal and state ARARs.

9.1.2 Primary Balancing Criteria

Long-term Effectiveness and Permanence. This describes the ability of a cleanup action to reliably protect human health and the environment over time after completion of cleanup. It addresses risks that may remain at the site.

Reduction of Toxicity, Mobility, or Volume Through Treatment. This describes how well the treatment technologies that may be used in a cleanup action work. Reduction of toxicity indicates contamination is destroyed. When mobility is reduced, contaminants are no longer able to migrate from the site. Reduction of volume indicates contamination is physically removed from the site.

TABLE 9-1. REMEDIAL ALTERNATIVES EVALUATED FOR SOILS AT THE PRIORITY 2a SITES

SITE	NO ACTION	INSTITUTIONAL CONTROLS & MONITORING	BIOVENTING	STEAM-ENHANCED SOIL VAPOR EXTRACTION	SOIL VAPOR EXTRACTION	EXCAVATION & SOIL WASHING	EXCAVATION & OFFSITE DISPOSAL	EXCAVATION & THERMAL DESORPTION
IS-4	X	[X]	X (Open system)	X	-	X	X	X
PS-1	X	X	[X] (Open system)	X	-	X	X	X
PS-5	X	[X] ^(a)	X (Closed system)	X	-	-	-	X
PS-7	X	[X] ^(a)	X (Closed system)	X	-	-	-	X
PS-10	X	[X]	-	X	X	X	[X]	X
FT-2	X	[X]	X (Open system)	X	-	X	X	X

(a) Institutional controls without monitoring

X = Evaluated alternative

[X] = Selected Remedy

TABLE 9-2. REMEDIAL ALTERNATIVES EVALUATED FOR GROUND WATER AT THE PRIORITY 2a SITES

SITE	NO ACTION	INSTITUTIONAL CONTROLS & MONITORING	BIOSPARGING	STEAM INJECTION WITH VAPOR EXTRACTION	PUMP & TREAT WITH TREATMENT USING CARBON ADSORPTION
PS-1	X	[X]	X	X	X
PS-5	X	[X]	X	X	X
PS-7	X	[X]	X	X	X
FT-2	X	[X]	X	X	X

X = Evaluated Alternative

[X] = Selected Remedy

Short-term Effectiveness. This describes how fast the cleanup action is able to protect human health and the environment and its potential to create adverse effects during construction and implementation.

Implementability. This describes how suitable a remedy is from a technical and administrative standpoint, including the availability of materials and services needed for the chosen solution. It considers how successful the technology has been on other similar sites.

Cost. This describes what the estimated costs are of the alternative. Estimated capital costs, annual operation and maintenance costs, and net present value for each alternative are presented in following sections.

9.1.3 Modifying Criteria

State Acceptance. This describes whether, based on its review of the project documents and proposed plan, the state agrees with, opposes, or has no comment on the selected remedy. The State of Washington concurs with all selected remedies presented in this Record of Decision.

Community Acceptance. This describes what the community's comments or concerns are about the selected remedy and whether the community generally supports or opposes them.

9.2 SITE IS-4 SOIL CONTAMINATION

The following remedial alternatives were evaluated for IS-4 soil contamination:

- No Action;
- Institutional Controls and Monitoring;
- Bioventing (Open System);
- Steam-Enhanced Soil Vapor Extraction;
- Excavation and Thermal Desorption;
- Excavation and Soil Washing; and
- Excavation and Offsite Disposal.

The selected remedy for remediating petroleum contamination in soils at Site IS-4 is institutional controls and monitoring. Based on current information, this alternative provides the best balance of trade-offs among the alternatives with respect to the nine criteria provided by EPA. This section profiles the performance of the selected remedy against the nine criteria, noting how it compares to the other alternatives under consideration.

9.2.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls and monitoring will rely on natural biodegradation to reduce toxicity of petroleum. Institutional controls, already in place, will control human contact

with contaminants. Monitoring will add to protectiveness of this alternative by detecting any tendency for migration of contaminants so that appropriate actions can be taken to prevent offsite migration. Monitoring will also be used to measure the natural biodegradation of petroleum residues. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during excavation or drilling.

9.2.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing the volume or toxicity of petroleum residues in site soil.

The "No Action" alternative is not protective of human health and the environment. It is therefore dropped from consideration at this site.

9.2.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum compounds are either biodegraded in place, or extracted and removed from the site. Excavation combined with offsite disposal, soil washing, or thermal desorption are the most effective because all contaminated media is removed from the site. Offsite disposal without treatment is the least preferred option under CERCLA in part because it simply relocates the contamination rather than reducing or eliminating it. Soil washing and thermal desorption are better alternatives, because they treat the soil and effectively destroy both low and high volatility organics. The steam-enhanced soil vapor extraction will remove most organics, regardless of volatility. Open system bioventing and institutional controls and monitoring may provide long term effectiveness and permanence but may not remediate all organic components equally well.

9.2.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

Excavation combined with offsite disposal, soil washing, and thermal desorption will result in approximately a 100% reduction in volume of onsite petroleum contamination. The steam enhanced soil vapor extraction alternative will also reduce the volume of petroleum residues, but less than excavation alternatives. Open system bioventing and institutional controls and monitoring rely on biodegradation to reduce toxicity of petroleum residues. Biodegradation reduces toxicity by transforming the hazardous components of petroleum residues into carbon dioxide, water, and fatty acids. The non-hazardous components that remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.2.5 Short-term Effectiveness

Excavation combined with offsite disposal, soil washing, and thermal desorption would meet cleanup levels in the shortest time frame. Health and safety requirements will have to be implemented for workers performing the cleanup activities to protect them from physical hazards associated with excavation and exposure to contaminated media. Steam-enhanced soil vapor

extraction and open system bioventing would take a longer time frame to achieve cleanup levels than the excavation based alternatives. For both these alternatives, precautions will need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. Institutional controls and monitoring would take the longest time frame to reach cleanup levels. Institutional controls and monitoring has the advantage that there are no physical hazards associated with heavy equipment and worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.2.6 Implementability

All the alternatives will meet administrative implementability requirements, however, steam-enhanced soil vapor extraction will require management of air emissions and soil washing will require management of air emissions and discharged water. All alternatives are also technically implementable, although, steam-enhanced soil vapor extraction, open system bioventing and soil washing may require treatability testing to confirm that they are effective at the site. These remedies have been used successfully to address similar contaminants at other Superfund sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.2.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-3. The highest cost alternatives involve soil excavation. Offsite disposal, soil washing, and thermal desorption have estimated net present values of \$674,105, \$507,250, and \$406,015, respectively. Aggressive in place alternatives are the next most expensive. Steam-enhanced soil vapor extraction and open system bioventing have estimated net present values of \$365,055 and \$268,522, respectively. Institutional controls and monitoring has an estimated net present value of \$123,870. Institutional controls alone has an estimated net present value of \$14,500.

9.2.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.2.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed Plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comment period indicate local businesses are concerned that institutional controls (with or without long term monitoring) is not an aggressive enough remedy and circumvents the intent of the Model Toxins Control Act. The Air Force addresses this comment in the Responsiveness Summary contained in Appendix B.

TABLE 9-3. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE IS-4 SOIL

ALTERNATIVE	COST ESTIMATES
No Action	Capital Cost: \$14,500 Annual Operation & Maintenance: \$0 Net Present Value: \$14,500
Institutional Controls & Monitoring [Selected Remedy] (3 years O&M)	Capital Cost: \$113,445 Annual Operation & Maintenance: \$1,300 Net Present Value: \$123,870
Bioventing (Open System) (2 years O&M)	Capital Cost: \$240,463 Annual Operation & Maintenance: \$1,300 Net Present Value: \$268,522
Steam-Enhanced Soil Vapor Extraction (2 years O&M)	Capital Cost: \$304,800 Annual Operation & Maintenance: \$2,600 Net Present Value: \$365,055
Excavation & Thermal Desorption	Capital Cost: \$231,855 Annual Operation & Maintenance: \$0 Net Present Value: \$406,015
Excavation & Soil Washing	Capital Cost: \$279,650 Annual Operation & Maintenance: \$0 Net Present Value: \$507,250
Excavation & Offsite Disposal	Capital Cost: \$316,305 Annual Operation & Maintenance: \$0 Net Present Value: \$674,105

Net present value based on 5% annual discount rate.

O&M = Operations and Maintenance.

9.2.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contaminated soil at IS-4 is institutional controls and monitoring. Institutional controls already in place restrict civilian site access. Any intrusive activities at the site require a Work Clearance Permit. The site is located adjacent to the flightline, so only Air Force personnel or authorized contractors can gain access. Personnel requesting site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. Soil sampling will be conducted to monitor petroleum degradation and migration.

Institutional controls and monitoring will protect human health by preventing exposure to contaminated soil while petroleum contamination biodegrades. Contaminant migration to ground water is not expected because the site is located in a low permeability clay basin, limiting the possibility of contaminant migration from site soil. Implementation of the selected remedy poses no technical, administrative, or logistical problems. Institutional controls and monitoring is one of the most cost effective alternatives and has the advantage that workers will not be exposed to physical and contaminant hazards associated with excavating or drilling. The Air Force believes, based on information currently available, institutional controls and monitoring provides the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121(b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

9.3 SITE PS-1 GROUND WATER CONTAMINATION

The following remedial alternatives were evaluated for PS-1 ground water contamination:

- No Action;
- Institutional Controls and Monitoring;
- Biosparging;
- Steam Injection with Vapor Extraction; and
- Pump and Treat using Carbon Adsorption.

The selected remedy for remediating contaminants of concern in ground water at Site PS-1 is institutional controls and monitoring. Contaminants of concern in ground water at PS-1 are petroleum residues and benzene. Based on current information, this alternative provides the best balance of trade-offs among the alternatives with respect to the nine criteria EPA provides to evaluate alternatives. This section profiles the performance of the selected remedy against the nine criteria, noting how it compares to the other alternatives under consideration.

9.3.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls and monitoring will rely on natural biodegradation to reduce toxicity of petroleum and benzene. Institutional controls, already in place, will control human contact with contaminants. Monitoring will add to protectiveness of this alternative by detecting any tendency for migration of contaminants so that appropriate actions can be taken to prevent offsite migration. Monitoring will also be used to measure the natural biodegradation of petroleum residues and benzene. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during intrusive activities.

9.3.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing the volume or toxicity of petroleum residues in site ground water.

The "No Action" alternative is not protective of human health and the environment. It is therefore dropped from consideration at this site.

9.3.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum is either biodegraded in place, or extracted from the ground water and removed from the site. Institutional controls and monitoring and biosparging can give good long term effectiveness and permanence but may not remediate all organic components equally well. Steam injection with vapor extraction and pump and treat with carbon adsorption reduce the volume of contaminants to yield long term effectiveness and permanence.

9.3.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

It is estimated pump and treat with carbon adsorption will reduce the volume of contaminants of concern in ground water by up to 1 00%. Steam injection with vapor extraction will also result in volume reduction of petroleum residues and benzene, but probably less than pump and treat. Biosparging and institutional controls and monitoring rely on biodegradation to reduce toxicity of contaminants of concern. Biodegradation reduces toxicity by transforming the hazardous components of contaminants of concern into carbon dioxide, water, and fatty acids. The non-hazardous components that remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.3.5 Short-Term Effectiveness

Biosparging would be the fastest alternative to reach cleanup levels. Steam injection with vapor extraction and pump and treat using carbon adsorption would be slower to reach cleanup levels than biosparging. Institutional controls and monitoring would require the longest time frame to

achieve cleanup levels. For steam injection with vapor extraction, biosparging, and pump and treat using carbon adsorption, precautions would need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. Institutional controls and monitoring has the advantage that there are no physical hazards associated with heavy equipment and worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.3.6 Implementability

All the alternatives will meet administrative implementability requirements. Steam injection with soil vapor extraction will, however, require management of air emissions and discharged water, and pump and treat will require management of pumped ground water. All alternatives are also technically implementable, although, steam injection with vapor extraction and biosparging may require treatability testing to confirm they are effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.3.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-4. The highest cost alternative, steam injection with vapor extraction, has an estimated present net value of \$1,039,434. Pump and treat using carbon adsorption and biosparging have estimated net present values of \$938,461 and \$286,994, respectively. Institutional controls and monitoring is the least expensive with an estimated net present value of \$134,763. Institutional controls alone has an estimated net present value of \$14,500.

9.3.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.3.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comment period indicate local businesses believe institutional controls (with or without monitoring) are not adequately aggressive, and circumvents the intent of the MTCA. The Air Force addresses this comment in the Responsiveness Summary contained in Appendix B.

**TABLE 9-4. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE PS-1
GROUND WATER**

ALTERNATIVE	COST ESTIMATES
No Action	Capital Cost: \$14,500 Annual Operation & Maintenance: \$0 Net Present Value: \$14,500
Institutional Controls & Monitoring [Selected Remedy] (4 years O&M)	Capital Cost: \$118,103 Annual Operation & Maintenance: \$1,300 Net Present Value: \$134,763
Biosparging (2 years O&M)	Capital Cost: \$247,630 Annual Operation & Maintenance: \$2,600 Net Present Value: \$286,994
Pump & Treat using Carbon Adsorption (12 years O&M)*	Capital Cost: \$510,583 Annual Operation & Maintenance: \$43,455 Net Present Value: \$938,461
Steam Injection with Vapor Extraction (4 years O&M)	Capital Cost: \$521,251 Annual Operation & Maintenance: \$2,600 Net Present Value: \$1,039,434

Net present value based on 5% annual discount rate.

O&M = Operations and Maintenance.

O&M time estimate assumes current plume configuration and no natural attenuation. Complimentary natural attenuation could reduce O&M time to less than 4 years for pump & treat using carbon adsorption.

9.3.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum residues and benzene contaminated ground water at Site PS-1 is institutional controls and monitoring. During site cleanup, human health will be protected by institutional controls already in place. Any intrusive activities require a Work Clearance Permit. Personnel requesting site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. Ground water sampling will be conducted to monitor contaminant of concern degradation and migration.

Institutional controls and monitoring will protect human health and the environment by reducing the toxicity of contaminants of concern in site ground water. Implementation of the selected remedy poses no technical, administrative, or logistical problems. The selected remedy is one of the most cost effective alternatives for all alternatives considered. The selected remedy has the advantage that workers will not be exposed to physical and contaminant hazards associated with intrusive activities. The Air Force believes, based on information currently available, the selected remedy provides the best balance of trade-offs with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121(b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

9.4 SITE PS-1 SOIL CONTAMINATION

The following remedial alternatives were evaluated for PS-1 soil contamination:

- No Action;
- Institutional Controls and Monitoring;
- Bioventing (Open System);
- Steam-Enhanced Soil Vapor Extraction;
- Excavation and Thermal Desorption;
- Excavation and Soil Washing; and
- Excavation and Offsite Disposal.

The selected remedy for remediating petroleum contaminated soils at Site PS-1 is open system bioventing. Based on current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to EPA's nine criteria. This section discusses the performance of the selected remedy against the nine criteria, noting how it compares to the other options under consideration.

9.4.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Open system bioventing will rely on natural biodegradation to reduce toxicity of petroleum. Institutional controls already in place a permit system for intrusive activities. These controls will regulate human contact with contaminants. Soil sampling will add to the protectiveness of this alternative by ensuring contamination does not migrate offsite and by measuring natural biodegradation of petroleum. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during excavation. Alternatives which involve excavation incur the additional hazard of operating heavy equipment adjacent to jet fuel storage tanks and pipelines.

9.4.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing the volume or toxicity of petroleum residues in site soil.

The "No Action" alternative is not protective of human health and the environment. It is therefore dropped from consideration at this site.

9.4.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum contamination is either biodegraded in place, or extracted and removed from the site. Excavation combined with offsite disposal, soil washing, or thermal desorption are the most effective because all contaminated media is removed from the site. Offsite disposal without treatment is the least preferred option under CERCLA in part because it simply relocates the contamination rather than reducing or eliminating it. Soil washing and thermal desorption provide better long term alternatives, because they treat the soil and destroy both low and high volatility organics. Steam-enhanced soil vapor extraction will remove most organics, regardless of volatility. Institutional controls and monitoring and open system bioventing may provide good long term effectiveness and permanence but may not remediate all organic components equally well.

9.4.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

Excavation combined with offsite disposal, soil washing, and thermal desorption all result in approximately a 100% reduction in volume of onsite petroleum contamination. Steam-enhanced soil vapor extraction alternative will also reduce the volume of petroleum, but less than the excavation alternatives. Open system bioventing and institutional controls and monitoring rely on biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.4.5 Short-term Effectiveness

Open system bioventing would be the fastest alternative to achieve cleanup levels. Excavation combined with offsite disposal, soil washing, and thermal desorption would be the next fastest alternatives to reach cleanup levels. Health and safety requirements would have to be implemented for workers performing the cleanup activities to protect them from physical hazards associated with excavation adjacent to jet fuel storage tanks and pipelines, and exposure to contaminated media. Institutional controls and monitoring would take longer to reach cleanup levels than excavation based alternatives. The steam-enhanced soil vapor extraction alternative would take the longest time frame to meet cleanup levels. For steam-enhanced soil vapor extraction and open system bioventing, precautions would need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.4.6 Implementability

All the alternatives meet administrative implementability requirements. Steam-enhanced soil vapor extraction will, however, require management of air emissions and soil washing will require management of air emissions and discharged water. Steam-enhanced soil vapor extraction, soil washing, and open system bioventing may require treatability testing to confirm they are effective. An open system bioventing pilot project is currently in operation. Initial results indicate open system bioventing will significantly enhance the oxygen content of the soil thereby increasing the biodegradation rate of petroleum contaminants in the soil. Issues related to worker safety, disruption of facility operations, and impacts to the structural integrity of site facilities make alternatives involving excavation at this site technically non-implementable. All the alternatives considered have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.4.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-5. The highest cost alternatives involve soil excavation. Offsite disposal, soil washing, and thermal desorption have estimated net present values of \$10,902,695, \$6,623,074, and \$5,274,100, respectively. Aggressive in place alternatives are the next most expensive. Steam-enhanced soil vapor extraction and open system bioventing have estimated net present values of \$1,129,234 and \$266,380, respectively. Institutional controls and monitoring, is the least expensive alternative with an estimated net present values of \$122,511. Institutional controls alone has an estimated net present value of \$14,500.

9.4.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

TABLE 9-5. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE PS-1 SOIL

ALTERNATIVE	COST ESTIMATES	
No Action	Capital Cost:	\$14,500
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$14,500
Institutional Controls & Monitoring (2 years O&M)	Capital Cost:	\$113,021
	Annual Operation & Maintenance:	\$1,300
	Net Present Value:	\$122,511
Bioventing (Open System) [Selected Remedy] (2 years O&M)	Capital Cost:	\$241,475
	Annual Operation & Maintenance:	\$1,300
	Net Present Value:	\$266,380
Steam-Enhanced Soil Vapor Extraction (4 years O&M)	Capital Cost:	\$549,425
	Annual Operation & Maintenance:	\$2,600
	Net Present Value:	\$1,129,234
Excavation & Thermal Desorption	Capital Cost:	\$1,742,640
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$5,274,100
Excavation & Soil Washing	Capital Cost:	\$2,192,874
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$6,623,074
Excavation & Offsite Disposal	Capital Cost:	\$3,505,395
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$10,902,695

Net present value based on 5% annual discount rate.

O&M = Operation and Maintenance

9.4.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comment period indicate local businesses are concerned about the efficiency and short term effectiveness of the open system bioventing alternative. Community response to the Proposed Plan is presented in the Responsiveness Summary located in Appendix B.

9.4.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contamination in PS-1 soil is open system bioventing. An open system bioventing pilot project is already in progress. Initial test results indicate open system bioventing will increase the oxygen content of the soil and enhance natural bioremediation of petroleum products in the soil. During site cleanup, human health will be protected by institutional controls already in place. Any intrusive activities require a Work Clearance Permit. Personnel requesting site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants.

Contaminant migration to ground water is not expected because the site is located on top of a low permeability clay layer, limiting the possibility of petroleum migration from site soil. Implementation of the selected remedy poses no technical, administrative, or logistical problems since a pilot system is already in place. Open system bioventing is one of the most cost effective alternatives and has the advantage that workers will not be exposed to physical and contaminant hazards associated with excavation adjacent to jet fuel storage tanks and pipelines. The Air Force believes, based on information currently available, the selected remedy provides the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121 (b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, utilizes a permanent solution to the maximum extent practicable, and will satisfy the statutory preference for treatment.

9.5 SITE PS-5 GROUND WATER CONTAMINATION

The following remedial alternatives were evaluated for PS-5 ground water contamination:

- No Action;
- Institutional Controls and Monitoring;
- Biosparging;
- Steam Injection with Vapor Extraction; and
- Pump and Treat using Carbon Adsorption.

The selected remedy for remediating petroleum contamination in ground water at Site PS-5 is institutional controls and monitoring. Based on current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to the nine criteria EPA uses to evaluate alternatives. This section profiles the performance of the selected remedy against the nine criteria, noting how it compares to the other options under consideration.

9.5.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls and monitoring relies on natural biodegradation to reduce toxicity of petroleum. Institutional controls, already in place, will regulate human contact with contaminants. Monitoring will add to protectiveness of this alternative by detecting any tendency for migration of contaminants so that appropriate actions can be taken to prevent offsite migration. Monitoring will also be used to measure the natural biodegradation of petroleum residues. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during intrusive activities.

9.5.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing the volume or toxicity of petroleum residues in site ground water.

The "No Action" alternative is not protective of human health and the environment. It is therefore dropped from consideration at this site.

9.5.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum is either biodegraded in place, or extracted from the ground water and removed from the site. Institutional controls and monitoring and biosparging may provide good long term effectiveness and permanence but may not remediate all organic components of petroleum equally well. Steam injection with vapor extraction and pump and treat with carbon adsorption reduce the volume of contaminants to yield long term effectiveness and permanence.

9.5.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

It is estimated pump and treat with carbon adsorption will reduce the volume of petroleum in ground water by up to 100%. Steam injection with vapor extraction will result in petroleum volume reduction, but probably less than pump and treat. Biosparging and institutional controls and monitoring rely on biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.5.5 Short-term Effectiveness

Steam injection with vapor extraction would be the fastest alternative to meet cleanup levels. Biosparging and pump and treat using carbon adsorption would be the next fastest alternatives to meet cleanup levels. Institutional controls and monitoring would require the longest time frame to achieve cleanup levels. For steam injection with vapor extraction, biosparging, and pump and treat using carbon adsorption, precautions would need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. Institutional controls and monitoring has the advantage that there are no physical hazards associated with heavy equipment and worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.5.6 Implementability

All of the alternatives will meet administrative implementability requirements, however, steam injection with soil vapor extraction will require management of air emissions and discharged water, and pump and treat will require management of pumped ground water. All alternatives are also technically implementable, although, steam injection with vapor extraction and biosparging may require treatability testing to confirm they are effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.5.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-6. The highest cost alternative is pump and treat using carbon adsorption with an estimated present net value of \$938,461. Steam injection with vapor extraction and biosparging have estimated net present values of \$325,510 and \$268,596, respectively. The in place alternative, institutional controls and monitoring, is the least expensive with a net present value of \$132,093. Institutional controls alone has an estimated net present value of \$14,500.

9.5.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.5.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comments period indicate local businesses believe institutional controls (with or without monitoring) is not adequately aggressive, and circumvents the intent of the MTCA. The Air Force addresses this comment in the Responsiveness Summary contained in Appendix B.

**TABLE 9-6. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE PS-5
GROUND WATER**

ALTERNATIVE	COST ESTIMATES
No Action	Capital Cost: \$14,500 Annual Operation & Maintenance: \$0 Net Present Value: \$14,500
Institutional Controls & Monitoring [Selected Remedy] (2 years O&M)	Capital Cost: \$117,274 Annual Operation & Maintenance: \$1,300 Net Present Value: \$132,093
Biosparging (2 years O&M)	Capital Cost: \$241,920 Annual Operation & Maintenance: \$2,600 Net Present Value: \$268,596
Steam Injection with Vapor Extraction (2 years O&M)	Capital Cost: \$291,838 Annual Operation & Maintenance: \$2,600 Net Present Value: \$325,510
Pump & Treat using Carbon Adsorption (12 years O&M)	Capital Cost: \$510,583 Annual Operation & Maintenance: \$43,455 Net Present Value: \$938,461

Net present value based on 5% annual discount rate.

O&M = Operations and Maintenance.

O&M time estimate assumes current plume configuration and no natural attenuation. Complimentary natural attenuation could reduce O&M time to less than 2 years for pump and treat using carbon adsorption.

9.5.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contaminated ground water at Site PS-5 is institutional controls and monitoring. Institutional controls already in place require a Work Clearance Permit before any intrusive activities are conducted. Personnel requesting intrusive access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. Ground water sampling will be conducted to monitor petroleum degradation and migration.

Institutional controls and monitoring will protect human health by preventing exposure to contaminated soil while petroleum biodegrades. Implementation of the selected remedy poses no technical, administrative, or logistical problems. Institutional controls and monitoring is one of the most cost effective alternatives and has the advantage that workers and residents in adjacent housing will not be exposed to physical and contaminant hazards associated with intrusive activities or steam production. The Air Force believes, based on information currently available, the selected remedy provides the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion.

The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121(b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

9.6 SITE PS-5 SOIL CONTAMINATION

The following remedial alternatives were evaluated for PS-5 soil contamination:

- No Action;
- Institutional Controls (Without Monitoring);
- Bioventing (Closed System);
- Steam-Enhanced Soil Vapor Extraction; and
- Excavation and Thermal Desorption;

The selected remedy for remediating petroleum contaminated soils at Site PS-5 is institutional controls (without monitoring). Based on current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to the nine criteria EPA uses to evaluate alternatives. This section profiles the performance of the selected remedy against the nine criteria, noting how it compares to the other options under consideration.

9.6.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls will rely on natural biodegradation to reduce toxicity

of petroleum. Institutional controls, already in place, will control human contact with contaminants. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during intrusive activities.

9.6.2 COMPLIANCE WITH ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing either toxicity or volume of petroleum in site soil.

The "No Action" alternative is not protective of human health and the environment. It is therefore dropped from consideration at this site.

9.6.3 Long-term Effectiveness and Permanence

All alternative is offer some degree of long term effectiveness and permanence because petroleum is either biodegraded in place! or extracted and destroyed offside.. Excavation and thermal desorption it the most effective because all contaminated media is removed from the site. Excavation and thermal desorption effectively destroys both low and high volatility organics. Steam-enhanced soil vapor extraction will remove most organics, regardless of volatility. Closed system bioventing and institutional controls may provide good long term effectiveness and permanence but may not remediate all organic components of petroleum equally well.

9.6.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

Excavation and thermal desorption will result in approximately a 100% reduction in volume of petroleum contamination. Steam-enhanced soil vapor extraction will result in a reduction of volume of petroleum, but less than excavation and thermal desorption. Closed system bioventing and institutional controls rely on biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscosity weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible

9.6.5 Short-term Effectiveness

Excavation and thermal desorption and steam-enhanced soil vapor extraction would be the fastest alternatives to meet cleanup levels. Closed system bioventing would be the next fastest alternative to achieve cleanup levels. For these alternatives, health and safety requirements would have to be implemented for workers performing the cleanup activities to protect them from physical hazards associated with excavation, drilling, and exposure to contaminated media. Institutional controls and monitoring would take the longest time frame to achieve cleanup levels. Institutional controls has the advantage that there are no physical hazards associated with heavy equipment al ad worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.6.6 Implementability

All the alternatives will meet administrative implementability requirements, however, steam enhanced soil vapor extraction will require management of air emissions. All alternatives are also technically implementable, although, steam-enhanced soil vapor extraction and closed system bioventing may require treatability testing to confirm they are effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.6.7 Cost

The capital 4 Host, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-7. Aggressive in place alternatives are the most expensive at this site. Steam-enhanced soil vapor extraction and closed system bioventing have estimated net present values of \$326,750 and \$274,026, respectively. Excavation and thermal desorption has an estimated net present value of \$1 88,232. Institutional controls has an estimated net present value of \$ 4, 500.

9.6.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.6.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 1 30 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comments period indicate local businesses believe institutional controls (with or without monitoring) is not adequately aggressive, and circumvents the intent of the MTCA. The Air Force addresses this comment in the Responsiveness Summary contained in Appendix B.

9.6.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contamination in PS-5 soil is institutional controls (without monitoring). Institutional controls already in place require a Work Clearance Permit before any intrusive activities are conducted. Personnel requesting intrusive access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants.

Institutional controls will protect human health by preventing exposure to contaminated soil while petroleum biodegrades. Implementation of the selected remedy poses no technical, administrative, or logistical problems. Institutional controls is one of the most cost effective alternatives and has the advantage that workers and residents in adjacent housing will not be exposed to physical and contaminant hazards associated with any intrusive activities. Ground

TABLE 9-7. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE PS-5 SOIL

ALTERNATIVE	COST ESTIMATES	
No Action	Capital Cost:	\$14,500
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$14,500
Institutional Controls (Without Monitoring) [Selected Remedy]	Capital Cost:	\$14,500
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$14,500
Excavation & Thermal Desorption	Capital Cost:	\$164,267
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$188,232
Bioventing (Closed System) (2 years O&M)	Capital Cost:	\$243,330
	Annual Operation & Maintenance:	\$1,300
	Net Present Value:	\$274,026
Steam-Enhanced Soil Vapor Extraction (2 years O&M)	Capital Cost:	\$292,997
	Annual Operation & Maintenance:	\$2,600
	Net Present Value:	\$326,750

Net present value based on 5% annual discount rate.

O&M = Operations and Maintenance.

water monitoring (discussed under the PS-5 ground water section) will be used to guard against migration of contamination from site soil into ground water. The Air Force believes, based on information currently available, the selected remedy provides the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121 (b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

9.7 SITE PS-7 GROUND WATER CONTAMINATION

The following remedial alternatives were evaluated for PS-7 ground water contamination:

- No Action;
- Institutional Controls and Monitoring
- Biosparging;
- Steam Injection with Vapor Extraction; and
- Pump and Treat using Carbon Adsorption.

The selected remedy for remediating petroleum contaminated ground water at Site PS-7 is institutional controls and monitoring. Based on current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to the nine criteria EPA uses to evaluate alternatives. This section profiles the performance of the selected remedy against the line criteria, noting how it compares to the other options under consideration.

9.7.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Actions will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls and monitoring will rely on natural biodegradation to reduce toxicity of petroleum. Institutional controls, already in place, will regulate human contact with contaminants. Monitoring will add to protectiveness of this alternative by detecting any tendency for migration of contaminants so that appropriate actions can be taken to prevent offsite migration. Monitoring will also be used to measure the natural biodegradation of petroleum residues. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during intrusive activities.

9.7.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing either the volume or toxicity of petroleum in site ground water.

The "No Action" alternative is not protective of human health and environment. It was therefore dropped from consideration at this site.

9.7.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum is either biodegraded in place, or extracted from the ground water and removed from the site. Institutional controls and monitoring and biosparging can provide good long term effectiveness and permanence but may not remediate all organic components of petroleum equally well. Steam injection with vapor extraction and pump and treat with carbon adsorption reduce the volume of contaminants to yield long term effectiveness and permanence.

9.7.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

It is estimated pump and treat with carbon adsorption will reduce the volume of petroleum in ground water by up to 100%. Steam injection with vapor extraction will result in a reduction of contaminant volume, but probably less than pump and treat. Open system bioventing and institutional controls and monitoring rely on natural biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.7.5 Short-term Effectiveness

Steam injection with vapor extraction and biosparging would be the fastest alternatives to meet cleanup levels. Pump and treat using carbon adsorption would be the next fastest alternative to meet cleanup levels. Institutional controls and monitoring would take the longest time frame to achieve cleanup levels. For steam injection with vapor extraction, biosparging, and pump and treat using carbon adsorption, precautions would need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. Institutional controls and monitoring has the advantage that there are no physical hazards associated with heavy equipment and worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.7.6 Implementability

All the alternatives will meet administrative implementability requirements, however, steam injection with soil vapor extraction will require management of air emissions and discharged water, and pump and treat will require management of pumped ground water. All alternatives are also technically implementable, although, steam injection with vapor extraction and biosparging may require treatability testing to confirm they are effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.7.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-8. The highest cost alternative is pump and treat using carbon adsorption with an estimated present net value of \$939,312. Steam injection with vapor extraction and biosparging have estimated net present values of \$349,693 and \$276,138, respectively. Institutional controls and monitoring has an estimated net present value \$134,232. Institutional controls alone has an estimated net present value of \$14,500.

9.7.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.7.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comments period indicate local businesses believe institutional controls (with or without monitoring) is not adequately aggressive, and circumvents the intent of the MTCA. The Air Force Addresses this comment in the Responsiveness Summary contained in Appendix B.

9.7.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contamination in PS-7 ground water is institutional controls with monitoring. Institutional controls already in place require a Work Clearance Permit before any intrusive activities are conducted. Personnel requesting intrusive access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. No. 6 fuel oil is the primary source of petroleum contamination at PS-7. Residual fuel oil is viscous, and is unlikely to migrate through the soil into the ground water. Ground water sampling will be conducted to monitor petroleum degradation and confirm no additional fuel oil migrates to ground water.

Institutional controls and monitoring will protect human health by preventing exposure to contaminated soil while petroleum biodegrades. Implementation of the selected remedy poses no technical, administrative, or logistical problems. Institutional controls and monitoring is one of the most cost effective alternatives and has the advantage that workers will not be exposed to physical and contaminant hazards associated with intrusive activities. The Air Force considers, based on information currently available, the selected remedy provides the best balance of trade-offs among

**TABLE 9-8. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE PS-7
GROUND WATER**

ALTERNATIVE	COST ESTIMATES
No Action	Capital Cost: \$14,500 Annual Operation & Maintenance: \$0 Net Present Value: \$14,500
Institutional Controls & Monitoring [Selected Remedy] (3 years O&M)	Capital Cost: \$118,027 Annual Operation & Maintenance: \$1,300 Net Present Value: \$134,232
Biosparging (2 years O&M)	Capital Cost: \$244,378 Annual Operation & Maintenance: \$2,600 Net Present Value: \$276,138
Steam Injection with Vapor Extraction (2 years O&M)	Capital Cost: \$299,611 Annual Operation & Maintenance: \$2,600 Net Present Value: \$349,693
Pump & Treat using Carbon Adsorption (12 years O&M)*	Capital Cost: \$510,965 Annual Operation & Maintenance: \$43,455 Net Present Value: \$939,312

Net present value based on 5% annual discount rate.

O&M = Operations and Maintenance.

O&M time estimates assume current plume configuration and no natural attenuation. Complimentary natural attenuation may reduce O&M time to less than 3 years for pump and treat using carbon adsorption.

the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121 (b), will be protective of human health and the environment will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

9.8 SITE PS-7 SOIL CONTAMINATION

The following remedial alternatives were evaluated for PS-7 soil contamination:

- No Action;
- Institutional Controls (Without Monitoring);
- Bioventing (Closed System);
- Steam-Enhanced Soil Vapor Extraction; and
- Excavation and Thermal Desorption.

The selected remedy for remediating petroleum contaminated soils at Site PS-7 is institutional controls (without monitoring). Based on current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to the nine criteria EPA uses to evaluate alternatives. This section profiles the performance of the selected remedy against the nine criteria, noting how it compares to the other options under consideration.

9.8.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls will rely on natural biodegradation to reduce toxicity of components of No. 6 fuel oil. Institutional controls, which include an excavation permit process already in place, will control human contact with contaminants. The protectiveness of institutional controls will be verified by ground water sampling (discussed in the selected remedy for PS-7 ground water section) which will be used to confirm no contaminants migrate into ground water. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during intrusive activities.

9.8.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing either toxicity or volume of petroleum in site soil.

The "No Action" alternative is not protective of human health and the environment. It was therefore dropped from consideration at this site.

9.8.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum is either biodegraded in place, or extracted and destroyed offsite. Excavation and thermal desorption is the most effective because all contaminated media are removed from the site. Thermal desorption effectively destroys both low and high volatility organics. Steam-enhanced soil vapor extraction will remove most organics, regardless of volatility. Closed system bioventing and institutional controls may provide good long term effectiveness and permanence but may not remediate all organic components of petroleum equally well.

9.8.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

Excavation and thermal desorption will result in approximately a 100% reduction in volume of petroleum contamination. Steam-enhanced soil vapor extraction alternative will result in a reduction of volume of petroleum, but less than excavation and thermal desorption. Closed system bioventing and institutional controls rely on biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.8.5 Short-term Effectiveness

Excavation and thermal desorption and steam-enhanced soil vapor extraction would be the fastest alternatives to reach cleanup levels. Health and safety requirements would have to be implemented for workers performing the cleanup activities to protect them from physical hazards associated with excavation activities, drill rigs, and exposure to contaminated media. Closed system bioventing would be the next fastest alternative to meet cleanup levels. For this alternative precautions would need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. Institutional controls would take require the longest time frame to achieve cleanup levels. Institutional controls has the advantage that there are no physical hazards associated with heavy equipment and worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.8.6 Implementability

All the alternatives will meet administrative implementability requirements, however, steam-enhanced soil vapor extraction will require management of air emissions. Technical implementability is an issue for excavation and thermal desorption because the majority of the soil contamination at this site lies beneath Building 1350. Excavation of the contaminated soil would threaten the structural integrity of the building. All other alternatives are technically implementable, although, steam-enhanced soil vapor extraction and closed system bioventing

may require treatability testing to confirm they are effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.8.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-9. Aggressive in place alternatives are the most expensive at this site. Steam-enhanced soil vapor extraction and closed system bioventing have estimated net present values of \$321,846 and \$267,335, respectively. Excavation and thermal desorption has an estimated net present value of \$171,376.

9.8.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.8.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comments period indicate local businesses believe institutional controls (with or without monitoring) is not adequately aggressive, and circumvents the intent of the MTCA. The Air Force addresses this comment in the Responsiveness Summary contained in Appendix B.

9.8.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contamination in PS-7 soil is institutional controls (without monitoring). Institutional controls already in place require a Work Closure Permit for intrusive activities. Personnel requesting intrusive access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. Most contaminated soil is located beneath Building 1350. The primary component of petroleum contamination at this site is No. 6 fuel oil. Fuel oil is viscous, and is unlikely to migrate through the soil or into the ground water. Ground water sampling (discussed in the selected remedy for PS-7 ground water section) will be used to confirm no fuel oil migrates into ground water.

Institutional controls will protect human health by preventing exposure to contaminated soil while petroleum biodegrades. Implementation of the selected remedy poses no technical, administrative, or logistical problems. Institutional controls is one of the most cost effective alternatives and has the advantage that workers will not be exposed to physical and contaminant hazards associated with excavating or intrusive activities. Ground water monitoring (discussed under the PS-7 ground water section) will be used to guard against migration of contamination from site soil into ground water. The Air Force considers, based on information currently

TABLE 9-9. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE PS-7 SOIL

ALTERNATIVE	COST ESTIMATES	
No Action	Capital Cost:	\$14,500
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$14,500
Institutional Controls (Without Monitoring) [Selected Remedy]	Capital Cost:	\$14,500
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$14,500
Excavation & Thermal Desorption	Capital Cost:	\$159,036
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$171,376
Bioventing (Closed System) (2 years O&M)	Capital Cost:	\$240,960
	Annual Operation & Maintenance:	\$1,300
	Net Present Value:	\$267,335
Steam-Enhanced Soil Vapor Extraction (2 years O&M)	Capital Cost:	\$291,240
	Annual Operation & Maintenance:	\$2,600
	Net Present Value:	\$321,846

Net present value based on 5% annual discount rate.

O&M = Operation and Maintenance.

available, the selected remedy provides the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121(b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

When Building 1350 is demolished, the Air Force will address underlying soil contamination.

9.9 SITE PS-10 SOIL CONTAMINATION

The following remedial alternatives were evaluated for PS-10 soil contamination:

- No Action;
- Institutional Controls and Monitoring;
- Soil Vapor Extraction;
- Steam-Enhanced Soil Vapor Extraction;
- Excavation and Thermal Desorption;
- Excavation and Soil Washing; and
- Excavation and Offsite Disposal (Including Pre-disposal Incineration).

The selected remedies for remediating contaminated soils at Site PS-10 are excavation and offsite disposal for TCE contamination and institutional controls and monitoring for petroleum contamination. Excavation and offsite disposal will target TCE contamination and institutional controls and monitoring will be used to remediate petroleum contamination. Based on current information, these alternatives appear to provide the best balance of trade-offs among the alternatives with respect to EPA's nine criteria. This section discusses the performance of the selected remedies against the nine criteria, noting how it compares to the other options under consideration.

9.9.1 Overall Protection of Human Health and the Environment

For petroleum contamination, the "No Action", steam-enhanced soil vapor extraction, and soil vapor extraction are not protective of human health and the environment. "No Action" would allow human exposure to contaminated surface soil, and provide no control over migration of contamination. Soil vapor extraction and steam-enhanced soil vapor extraction are not protective because they are rendered ineffective by the shallow and narrow site geometry. The remaining alternatives will provide at least adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls and monitoring is protective of human health and the environment because it relies on biodegradation to reduce the toxicity of contaminants while institutional controls limit human contact with contaminated soil. Monitoring will add to protectiveness of this alternative by detecting any tendency for migration of contaminants so that appropriate actions can be taken to prevent offsite migration. Monitoring will also be used to measure the natural

biodegradation of petroleum residues. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during excavation. Excavation combined with soil washing, thermal desorption, or offsite disposal are all protective of human health and the environment. These alternatives completely remove contaminated soil from the site and either treat or dispose of it offsite.

For TCE contamination, excavation and thermal desorption, excavation and soil washing, and excavation and offsite disposal (including pre-disposal incineration) are the only alternatives which are protective of human health and the environment. Under LDRs incineration is the BDAT for TCE contaminated soil. Alternatives based on biodegradation are not protective because TCE degrades to vinyl chloride which is a more hazardous waste than TCE.

9.9.2 Compliance with ARARS

For petroleum contamination, soil vapor extraction and steam-enhanced soil vapor extraction do not comply with ARARs because they are rendered ineffective by the shallow and narrow site geometry. Institutional controls and monitoring, and excavation combined with soil washing, thermal desorption, or offsite disposal all comply with ARARs.

For TCE contamination, excavation and soil washing, excavation and thermal desorption, and excavation and offsite disposal (including pre-disposal incineration) are the only alternatives that comply with ARARs. Alternatives based on biodegradation do not comply with ARARs because TCE degrades to vinyl chloride which is a more hazardous waste than TCE. Under LDR, incineration is the BDAT for TCE contaminated soil.

The "No Action", steam-enhanced soil vapor extraction, and soil vapor extraction alternatives do not comply with the threshold criteria for petroleum and TCE. They will therefore be dropped from further consideration at this site. The only alternatives to meet threshold criteria for TCE contaminated soil are excavation based.

9.9.3 Long-term Effectiveness and Permanence

For petroleum contamination, all alternatives offer some degree of long term effectiveness and permanence because petroleum is either biodegraded in place, or extracted and removed from the site. Excavation combined with offsite disposal, soil washing, or thermal desorption are the most effective and permanent because contaminated media is removed from the site. Offsite disposal without treatment is the least preferred option under Superfund. Thermal desorption is a better alternative, because it treats the soil and effectively destroy both low and high volatility organics. Institutional controls and monitoring provide good long term effectiveness and permanence, however, it may not remediate all organic components of petroleum equally well.

For TCE contamination, excavation combined with soil washing, thermal desorption, or offsite disposal (including predisposal incineration) are highly effective and permanent because all contaminated media is removed from the site and treated. Resulting decontaminated soil would be landfilled.

9.9.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

For petroleum contamination, excavation combined with offsite disposal, soil washing, or thermal desorption will result in approximately a 100% reduction in volume of onsite petroleum contamination. Institutional controls and monitoring rely on biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

For TCE contamination, excavation and offsite disposal, including predisposal incineration, will reduce the toxicity of TCE contaminated soil. Excavation combined with soil washing or thermal desorption will reduce the volume of contaminated media. Reduction in toxicity or volume resulting from these alternatives is irreversible.

9.9.5 Short-term Effectiveness

For petroleum contamination, excavation combined with thermal desorption, soil washing, and offsite disposal would be the fastest alternatives to meet cleanup levels. Health and safety requirements would have to be implemented for workers performing the cleanup activities to protect them from physical hazards associated with excavation, intrusive activities, and exposure to contaminated media. The institutional controls and monitoring alternative would take longer than the other alternatives to meet cleanup levels. Institutional controls and monitoring has the advantage that there are no physical hazards associated with heavy equipment and worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

For TCE contamination, all excavation based alternatives would meet cleanup levels very quickly. Health and safety requirements would have to be initiated for workers involved in the excavation, soil washing, thermal desorption, and incineration phases of the process.

9.9.6 Implementability

For petroleum contamination, all the alternatives will meet administrative implementability requirements, however, soil washing will require management of air emissions and discharged water. All alternatives are also technically implementable, although, soil washing may require treatability testing to confirm it is effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

For TCE contamination, all excavation based alternatives will meet both administrative and technical implementability requirements. Soil washing will require air emission and water discharge management, and thermal desorption may require air emission management. Soil washing may require treatability testing to confirm effectiveness.

9.9.7 Cost

For petroleum contamination, the capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-10. The highest cost alternatives involve soil excavation. Excavation, of 600 cubic yards of petroleum contaminated soil, combined with soil washing and thermal desorption have estimated net present values of \$304,975 and \$244,195, respectively. Institutional controls and monitoring for petroleum contaminated soil has an estimated net present value of \$125,182.

For TCE contamination, the capital cost, annual operation and maintenance cost, and net present value of for excavation and offsite disposal is shown in Table 9-10. The net present value of excavation and offsite disposal (including predisposal incineration) for 67 cubic yards of TCE contaminated soil is \$356,780.

9.9.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.9.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comments period indicate local businesses believe institutional controls (with or without monitoring) is not adequately aggressive, and circumvents the intent of the MTA. The Air Force addresses this comment in the Responsiveness Summary contained in Appendix B.

9.9.10 Summary of the Selected Remedy

The selected remedies for remediating TCE and petroleum contaminated in soils at Site PS-10 are excavation and offsite disposal, including predisposal incineration, and institutional controls and monitoring, respectively. Excavation and offside disposal will target TCE contamination and institutional controls and monitoring will be used to remediate petroleum contamination. Institutional controls already in place require a Work Clearance Permit to conduct intrusive activities. The site is located adjacent to the flightline, so only Air Force personnel and authorized contractors can gain access. Personnel requesting intrusive site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. Soil sampling will be conducted to monitor petroleum degradation.

TABLE 9-10. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE PS-10 SOIL

ALTERNATIVE	COST ESTIMATES	
No Action	Capital Cost:	\$14,500
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$14,500
Institutional Controls & Monitoring [Selected Remedy] (4 years O&M)	Capital Cost:	\$113,849
	Annual Operation & Maintenance:	\$1,300
	Net Present Value:	\$125,182
Steam-Enhanced Soil Vapor Extraction (2 years O&M)	Capital Cost:	\$296,937
	Annual Operation & Maintenance:	\$2,600
	Net Present Value:	\$340,392
Excavation & Thermal Desorption	Capital Cost:	\$181,635
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$244,195
Soil Vapor Extraction (2 years O&M)	Capital Cost:	\$264,157
	Annual Operation & Maintenance:	\$2,600
	Net Present Value:	\$328,970
Excavation & Soil Washing	Capital Cost:	\$216,875
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$304,975
Excavation & Offsite Disposal [Selected Remedy]	Capital Cost:	\$217,825
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$356,780

Net present value based on 5% annual discount rate.

O&M = Operation and Maintenance.

The selected remedies will destroy TCE contamination and protect human health by preventing exposure to contaminated soil while petroleum biodegrades. Implementation of the selected remedies pose no technical, administrative, or logistical problems. The selected remedies are the most cost effective alternatives and have the advantage that workers will be exposed to a minimum of physical and contaminant hazards associated with excavating. The Air Force considers, based on information currently available, the selected remedies provide the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121(b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because institutional controls and monitoring relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

9.10 SITE FT-2 GROUND WATER CONTAMINATION

The following remedial alternatives were evaluated for FT-2 ground water contamination:

- No Action;
- Institutional Controls and Monitoring;
- Biosparging;
- Steam Injection with Vapor Extraction; and
- Pump and Treat using Carbon Adsorption.

The selected remedy for remediating petroleum contamination in ground water at Site FT-2 is institutional controls and monitoring. Based on current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to EPA's nine criteria. This section discusses the performance of the selected remedy against the nine criteria, noting how it compares to the other options under consideration.

9.10.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls and monitoring will rely on natural biodegradation to reduce toxicity of petroleum. Institutional controls, already in place, will regulate human contact with contaminants while they biodegrade. Monitoring will add to protectiveness of this alternative by detecting any tendency for migration of contaminants so that appropriate actions can be taken to prevent offsite migration. Monitoring will also be used to measure the natural biodegradation of petroleum residues. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during intrusive activities.

9.10.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing either volume or toxicity of petroleum in site ground water.

The "No Action" alternative is not protective of human health and the environment from consideration at this site.

9.10.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum is either biodegraded in place, or extracted from the ground water and removed from the site. Institutional controls and monitoring and biosparging may provide good long term effectiveness and permanence but may not remediate all organic components of petroleum equally well. Steam injection with vapor extraction and pump and treat with carbon adsorption reduce the volume of contaminants to yield long term effectiveness and permanence.

9.10.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

It is estimated pump and treat with carbon adsorption will reduce the volume of petroleum in ground water by up to 100%. Steam injection with vapor extraction will result in petroleum volume reduction, but probably less than pump and treat. Open system bioventing and institutional controls and monitoring rely on biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.10.5 Short-term Effectiveness

Steam injection with vapor extraction would be the fastest alternative to meet cleanup levels. The next fastest alternatives to meet cleanup levels would be biosparging and pump and treat with carbon adsorption. For steam injection with vapor extraction, biosparging, and pump and treat using carbon adsorption, precautions would need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. Institutional controls and monitoring would require the longest time frame to achieve cleanup levels. Institutional controls and monitoring has the advantage that there are no physical hazards associated with intrusive activities equipment and worker exposure to contaminants. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.10.6 Implementability

All the alternatives will meet administrative implementability requirements, however, steam injection with soil vapor extraction will require management of air emissions and discharged water, and pump and treat will require management of pumped ground water. All alternatives

are also technically implementable, although, steam injection with vapor extraction and biosparging may require treatability testing to confirm they are effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.10.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-11. The highest cost alternative is pump and treat using carbon adsorption with an estimated present net value of \$936,760. Steam injection with vapor extraction and biosparging have estimated net present values of \$391,476 and \$297,888, respectively. Institutional controls and monitoring is the least expensive alternative with a net present value of \$1 34,461. Institutional controls alone has an estimated net present value of \$14,500

9.10.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.10.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comments period indicate local businesses believe institutional controls (with or without monitoring) is not adequately aggressive, and circumvents the intent of the MTCA. The Air Force Addresses this comment in the Responsiveness Summary contained in Appendix B.

9.10.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contamination in FT-2 ground water is institutional controls with monitoring. Institutional controls already require a Work Clearance Permit before any intrusive activities are conducted. Personnel requesting intrusive access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. Ground water sampling will be conducted to monitor petroleum degradation and confirm no additional petroleum migrates into ground water. The Air Force is considering installing additional ground water monitoring wells to better define the contaminant plume and monitor the decay of petroleum.

Institutional controls and monitoring will protect human health by preventing exposure to contaminated ground water while petroleum biodegrades. Implementation of the selected remedy poses no technical, administrative, or logistical problems. Institutional controls and monitoring is one of the most cost effective alternatives and has the advantage that workers will not be exposed to physical and contaminant hazards associated with intrusive activities. The Air

**TABLE 9-11. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE FT-2
GROUND WATER**

ALTERNATIVE	COST ESTIMATES	
No Action	Capital Cost:	\$14,500
	Annual Operation & Maintenance:	\$0
	Net Present Value:	\$14,500
Institutional Controls & Monitoring [Selected Remedy] (5 years O&M)	Capital Cost:	\$117,833
	Annual Operation & Maintenance:	\$1,300
	Net Present Value:	\$134,461
Biosparging (3 years O&M)	Capital Cost:	\$250,775
	Annual Operation & Maintenance:	\$2,600
	Net Present Value:	\$297,888
Steam Injection with Vapor Extraction (2 years O&M)	Capital Cost:	\$315,925
	Annual Operation & Maintenance:	\$2,600
	Net Present Value:	\$391,476
Pump & Treat using Carbon Adsorption (12 years O&M)*	Capital Cost:	\$509,820
	Annual Operation & Maintenance:	\$43,455
	Net Present Value:	\$936,760

Net present value based on 5% annual discount rate.

O&M = Operations and Maintenance.

O&M time estimate assumes current plume configuration and no natural attenuation. Complementary natural attenuation may reduce O&M time to less than 5 years for pump and treat using carbon adsorption.

Force, based on information currently available, considers the selected remedy as providing the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121 (b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

9.11 SITE FT-2 SOIL CONTAMINATION

The following remedial alternatives were evaluated for FT-2 soil contamination:

- No Action;
- Institutional Controls and Monitoring;
- Bioventing (Open System);
- Steam-Enhanced Soil Vapor Extraction;
- Excavation and Thermal Desorption;
- Excavation and Soil Washing; and
- Excavation and Offsite Disposal.

The selected remedy for petroleum contaminated soils at Site FT-2 is institutional controls and monitoring. Based on current information, this alternative appears to provide the best balance of trade-offs among the alternatives with respect to the nine criteria EPA uses to evaluate alternatives. This section discusses the performance of the selected remedy against the nine criteria, noting how it compares to the other options under consideration.

9.11.1 Overall Protection of Human Health and the Environment

All of the alternatives, except "No Action", will provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through removal, treatment, or institutional controls. Institutional controls and monitoring will rely on natural biodegradation to reduce toxicity of petroleum products. Institutional controls, already in place, will control human contact with contaminants. Monitoring will add to protectiveness of this alternative by detecting any tendency for migration of contaminants so that appropriate actions can be taken to prevent offsite migration. Monitoring will also be used to measure the natural biodegradation of petroleum residues. Natural treatment has the advantage of eliminating worker risk associated with physical hazards and contaminant exposure during any intrusive activities.

9.11.2 Compliance with ARARS

All action alternatives comply with location, action, and chemical-specific ARARs by reducing either the toxicity or volume of petroleum contamination in site soil.

The "No Action" alternative is no protective of human health and the environment. It is therefore dropped from consideration at this site.

9.11.3 Long-term Effectiveness and Permanence

All alternatives offer some degree of long term effectiveness and permanence because petroleum products are either biodegraded in place, or extracted and removed from the site. Excavation combined with offsite disposal, soil washing, or thermal desorption are the most effective because all contaminated media is removed from the site. Offsite disposal without treatment is the least preferred option under CERCLA. Soil washing and thermal desorption are better alternatives, because they treat the soil and effectively destroy both low and high volatility organics. Steam-enhanced soil vapor extraction will remove most organics, regardless of volatility. Open system bioventing and institutional controls and monitoring may provide good long term effectiveness and permanence but may not remediate all organic components of petroleum equally well.

9.11.4 Reduction of Toxicity, Mobility, or Volume of the Contaminants Through Treatment

Excavation combined offsite disposal, soil washing, and thermal desorption all result in approximately a 100% reduction in volume of onsite petroleum contamination. Steam-enhanced soil vapor extraction alternative will also reduce the volume of petroleum contamination, but less than the excavation alternatives. Open system bioventing and institutional controls and monitoring rely on biodegradation to reduce toxicity of petroleum. Biodegradation reduces toxicity by transforming the hazardous components of petroleum into carbon dioxide, water, and fatty acids. The non-hazardous components which remain are tar like and tend to form a viscous weathered residue. Reduction of toxicity or volume resulting from all alternatives is irreversible.

9.11.5 Short-term Effectiveness

Open system bioventing would be the fastest alternative to meet cleanup levels. For this alternative, precautions would need to be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. Excavation combined with offsite disposal, soil washing, and thermal desorption would be the next fastest alternatives to achieve cleanup levels. Health and safety requirements would have to be implemented for workers performing the cleanup activities to protect them from physical hazards associated with excavation and exposure to contaminated media. Institutional controls and monitoring will require more time than excavation based alternatives to achieve cleanup levels. Institutional controls and monitoring has the advantage that there are no physical hazards associated with heavy equipment and worker exposure to contaminants. Steam-enhanced soil vapor extraction would be the slowest alternative to meet cleanup levels. For this alternative, precautions would be taken to protect workers from physical hazards associated with drill rigs and exposure to hydrocarbon vapors. No detrimental impact on the surrounding communities is expected from any of the alternatives.

9.11.6 Implementability

All the alternatives will meet administrative implementability requirements. Steam-enhanced soil vapor extraction will, however, require management of air emissions and soil washing will require management of air emissions and discharged water. All alternatives are also technically implementable, although, steam-enhanced soil vapor extraction, open system bioventing and soil washing may require treatability testing to confirm they are effective. These remedies have been used successfully to address similar contaminants at other contaminated sites, and the skilled workers and materials needed to construct the remedies are readily available in the area.

9.11.7 Cost

The capital cost, annual operation and maintenance costs, and net present value for each alternative are listed in Table 9-12. The highest cost alternatives involve soil excavation. Offsite disposal, soil washing, and thermal desorption have estimated net present values of \$6,397,835, \$3,929,971, and \$3,129,985, respectively. Aggressive in place alternatives are the next most expensive. Steam-enhanced soil vapor extraction and open system bioventing have estimated net present values of \$782,766 and \$261,678, respectively. Institutional controls and monitoring has an estimated net present value of \$122,511. Institutional controls alone has an estimated net present value of \$14,500.

9.11.8 State Acceptance

The State of Washington has concurred with the selected remedy for this site.

9.11.9 Community Acceptance

On May 10, 1995, Fairchild AFB held a public meeting to discuss the Proposed plan for the Priority 2 Sites. Prior to this meeting, copies of the Proposed Plan were sent to over 130 local residents and other interested parties. Comments received during the public meeting and during the 30 day public comments period indicate local businesses believe institutional controls (with or without monitoring) is not adequately aggressive, and circumvents the intent of the MTCA. The Air Force addresses this comment in the Responsiveness Summary contained in Appendix B.

9.11.10 Summary of the Selected Remedy

The selected remedy for remediation of petroleum contamination in FT-2 soil is institutional controls and monitoring. Institutional controls already in place require a Work Clearance Permit for intrusive activities. The site is located adjacent to the flightline, so only Air Force personnel and authorized contractors can gain access. Personnel requesting site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. Soil sampling will be conducted to monitor petroleum degradation and migration.

TABLE 9-12. REMEDIAL ALTERNATIVE COST ESTIMATES FOR SITE FT-2 SOIL

ALTERNATIVE	COST ESTIMATES
No Action	Capital Cost: \$14,500 Annual Operation & Maintenance: \$0 Net Present Value: \$14,500
Institutional Controls & Monitoring [Selected Remedy] (2 years O&M)	Capital Cost: \$113,021 Annual Operation & Maintenance: \$1,300 Net Present Value: \$122,511
Bioventing (Open System) (2 years O&M)	Capital Cost: \$239,133 Annual Operation & Maintenance: \$1,300 Net Present Value: \$261,678
Steam-Enhanced Soil Vapor Extraction (3 years O&M)	Capital Cost: \$438,743 Annual Operation & Maintenance: \$2,600 Net Present Value: \$782,766
Excavation & Thermal Desorption	Capital Cost: \$1,077,225 Annual Operation & Maintenance: \$0 Net Present Value: \$3,129,985
Excavation & Soil Washing	Capital Cost: \$1,350,571 Annual Operation & Maintenance: \$0 Net Present Value: \$3,929,971
Excavation & Offsite Disposal	Capital Cost: \$2,101,035 Annual Operation & Maintenance: \$0 Net Present Value: \$6,397,835

Net present value based on 5% annual discount rate.

O&M = Operation and Maintenance.

Institutional controls and monitoring will protect human health by preventing exposure to contaminated soil while petroleum products biodegrade. Implementation of the selected remedy poses no technical, administrative, or logistical problems. Institutional controls and monitoring is one of the most cost effective alternatives and has the advantage that workers will not be exposed to physical and contaminant hazards associated with excavating or intrusive activities. The Air Force considers, based on information currently available, the selected remedy provides the best balance of trade-offs among the other alternatives with respect to the evaluation criteria. Ecology and EPA concur with this opinion. The Air Force expects the selected remedy will satisfy the statutory requirements in CERCLA section 121(b), will be protective of human health and the environment, will comply with ARARs, is cost-effective, and utilizes a permanent solution to the maximum extent practicable. Because the selected remedy relies on passive natural biodegradation of contaminants, it will not satisfy the statutory preference for treatment as a principal element.

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10.0 SELECTED REMEDIES

The following sections describe the remedies selected for each of the Priority 2a Sites.

10.1 RECIPROCATING ENGINE SHOP, BUILDING 2150 (IS-3)

The selected remedy for IS-3 is Institutional Controls. This selection is based on the results of the human health risk assessment, which determined that conditions at the site posed no unacceptable risks to human health. When Building 2150 is demolished, underlying soil will be assessed for PCBs and remediated if necessary.

10.2 JET ENGINE TEST STAND, BUILDING 3000 (IS-4)

The remedial action goal at IS-4 is to remediate soil to state cleanup levels. Contaminants detected in the deeper water bearing zones beneath and up gradient of this site are not associated with site activities and will be addressed under the Priority 3 Operable Unit. The selected remedy for soil contamination is Institutional Controls and Monitoring. The Air Force believes Institutional Controls and Monitoring provides the best balance of trade-offs with respect to the evaluation criteria (see also Section 9.2.10). This remedy consists of the following elements:

- Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities;
- Allow natural attenuation to reduce the concentration of petroleum contamination; and
- Monitoring the degradation of diesel range petroleum contamination in soil until the contamination level decreases below the state cleanup level of 200 mg/kg.

The estimated costs associated with this remedy are tabulated as shown.

IS-4	SOIL
	INSTITUTIONAL CONTROLS AND MONITORING
Capital Costs	\$113,445
Annual Operation and Maintenance Costs	\$1,300
Net Present Value	\$123,870

The following paragraphs present specific components of this remedy:

- A) Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities.

Intrusive activities require a Work Clearance Permit. The site is located adjacent to the flightline, and only authorized Air Force personnel or authorized contractors can gain access. Personnel requesting intrusive site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. In the event of base closure, the Air Force, in conjunction with EPA and Ecology, will evaluate the need for additional site activities relative to the Community Environmental Response Facilitation Act.

- B) Allow natural attenuation to reduce the concentration of petroleum contamination.

Natural attenuation includes a number of components that collectively contribute to the reduction in contamination. It is particularly effective for petroleum compounds and soluble or volatile compounds. Natural bacteria consume the individual components that make up the most common petroleum contaminants. In complex petroleum mixtures, components that are not consumed or are very recalcitrant, generally are also less bioavailable. The rate at which microbes degrade organic compounds depends on a variety of factors. Some of the more important ones include temperature; moisture; pH; oxygen availability; active surface area; the presence or absence of other chemical compounds which may act as nutrients, stimulants, toxins, or retardants; and competition from other bacterial species. Soluble materials disperse as ground water moves through the system, and volatile materials evaporate. Contaminants exposed to the surface are subject to photo-oxidation and ultraviolet degradation. Physical degradation may also play a role for contaminants at the surface as compaction or freeze-thaw action affect active surface area, particle size, and aeration.

- C) Monitoring the degradation of diesel range petroleum in site soil until the contamination level decreases below the state cleanup level of 200 mg/kg.

Soil sampling will be conducted to monitor the degradation and migration of petroleum contamination. Soil monitoring will be conducted in a phased manner starting on a semiannual basis. In conjunction with historic data, if a clear decline in contamination can be demonstrated, and that decline is consistent with current projections, sampling may be reduced to annual, biannual, and eventually longer terms as negotiated at that time. The point of compliance will be throughout the site. It is estimated that soil cleanup levels can be achieved in a 3-year time frame. If monitoring indicates this remedy will not attain cleanup levels within a reasonable time frame, which shall not exceed 30 years, the need for remedial action will be reevaluated by the Air Force, EPA, and Ecology.

10.3 BULK FUEL STORAGE AREA (PS-1)

The goals of the remedial action at PS-1 are to remediate ground water to state and MCL cleanup levels and to remediate soil to state cleanup levels. The selected remedy for soil remediation is Open System Bioventing. The selected remedy for ground water is Institutional Controls and Monitoring. The Air Force believes open system bioventing, and institutional controls and monitoring provide the best balance of trade-offs with respect to the evaluation criteria (see also Sections 9.3.10 and 9.4.10). These remedies consist of the following elements:

- Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities;
- Implementing an in place bioventing treatment system for diesel range petroleum contaminated soil until the contamination level decreases below the state cleanup level of 200 mg/kg;
- Allow natural attenuation to reduce the concentration of petroleum contamination; and
- Monitoring ground water across the site and down gradient to assess degradation and migration of diesel range petroleum and benzene until the contamination levels decrease below the state cleanup levels of 1,000 $\mu\text{g/L}$ and MCL of 5 $\mu\text{g/L}$, respectively.

The estimated costs associated with these remedies are tabulated as shown.

PS-1	SOIL	GROUND WATER
	OPEN SYSTEM BIOVENTING	INSTITUTIONAL CONTROLS AND MONITORING
Capital Costs	\$241,475	\$118,103
Annual Operation and Maintenance Costs	\$1,300	\$1,300
Net Present Value	\$266,380	\$134,763

The following paragraphs present specific components of these remedies:

- A) Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities.

During site cleanup, human health will be protected by institutional controls, some of which are already in place. Any intrusive activities require a Work Clearance Permit. Personnel requesting intrusive site access will be warned about site conditions and will be required to take appropriate

health and safety precautions to avoid exposure to contaminants. In the event of base closure, the Air Force, in conjunction with EPA and Ecology, will evaluate the need for additional site activities relative to the Community Environmental Response Facilitation Act.

- B) Implementing an in place bioventing treatment system for diesel range petroleum contaminated soil until the contamination level decreases below the state cleanup level of 200 mg/kg.

An open system bioventing pilot project is already in progress at the site. Initial test results indicate open system bioventing will increase the oxygen content of the soil and enhance natural biodegradation of petroleum in the soil. Information from the pilot project will be used to enhance the efficiency of an expanded bioventing system which will treat an estimated 16,000 cubic yards of petroleum contaminated soil. Bioventing effectiveness will be evaluated through soil sampling. The system will be operated until the soil cleanup level of 200 mg/kg for petroleum contamination is achieved. The point of compliance will be throughout the site. Necessary operation time is expected to be less than one year.

- C) Allow natural attenuation to reduce the concentration of petroleum contamination.

Natural attenuation includes a number of components that collectively contribute to the reduction in contamination. It is particularly effective for petroleum compounds and soluble or volatile compounds. Natural bacteria consume the individual components that make up the most common petroleum contaminants. In complex petroleum mixtures, components that are not consumed or are very recalcitrant, generally are also less bioavailable. The rate at which microbes degrade organic compounds depends on a variety of factors. Some of the more important ones include temperature; moisture; pH; oxygen availability; active surface area; the presence or absence of other chemical compounds which may act as nutrients, stimulants, toxins, or retardants; and competition from other bacterial species. Soluble materials disperse as ground water moves through the system, and volatile materials evaporate. Contaminants exposed to the surface are subject to photo-oxidation and ultraviolet degradation. Physical degradation may also play a role for contaminants at the surface as compaction or freeze-thaw action affect active surface area, particle size, and aeration.

- D) Monitoring ground water across the site and down gradient to assess degradation and migration of diesel range petroleum and benzene until the contamination level decreases below the state cleanup level of 1,000 $\mu\text{g/L}$ and MCL of 5 $\mu\text{g/L}$, respectively.

Ground water sampling will monitor contaminant of concern degradation and migration. Ground water monitoring will be conducted in a phased manner starting on a semiannual basis. In conjunction with historic data, if a clear decline in contamination can be demonstrated, and that decline is consistent with current projections, sampling may be reduced to annual, biannual and eventually longer terms as negotiated at that time. The MCL for benzene in groundwater is 5 $\mu\text{g/L}$. The point of compliance will be throughout the plume. It is estimated that ground water

cleanup levels can be achieved in a 4-year time frame. If monitoring indicates this remedy will not attain cleanup levels within a reasonable time frame, which shall not exceed 30 years, the need for remedial action will be reevaluated by the Air Force, EPA, and Ecology.

10.4 FUEL OIL STORAGE TANK AT WHERRY HOUSING (PS-5)

The goals of the remedial action at PS-5 are to remediate ground water to state cleanup levels and to remediate soil to state cleanup levels. The selected remedy for soil is Institutional Controls. The selected remedy for ground water is Institutional Controls and Monitoring. The Air Force believes institutional controls and institutional controls and monitoring provide the best balance of trade-offs with respect to the evaluation criteria (see also Sections 9.5.10 and 9.6.10). These remedies consist of the following elements:

- Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities;
- Allow natural attenuation to reduce the concentration of petroleum contamination; and
- Monitoring ground water across the site and down gradient to assess degradation and migration of diesel range petroleum contamination until the state cleanup level of 1,000 $\mu\text{g/L}$ is achieved.

The estimated costs associated with these remedies are tabulated as shown.

PS-5	SOIL	GROUND WATER
	INSTITUTIONAL CONTROLS	INSTITUTIONAL CONTROLS AND MONITORING
Capital Costs	\$14,500	\$117,274
Annual Operation and Maintenance Costs	\$0	\$1,300
Net Present Value	\$14,500	\$132,093

The following paragraphs present specific components of these remedies:

- A) Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities.

Institutional controls already in place require a Work Clearance Permit before intrusive activities are conducted. Personnel conducting intrusive activities will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to

contaminants. In the event of base closure, the Air Force, in conjunction with EPA and Ecology, will evaluate the need for additional site activities relative to the Community Environmental Response Facilitation Act.

B) Allow natural attenuation to reduce the concentration of petroleum contamination.

Natural attenuation includes a number of components that collectively contribute to the reduction in contamination. It is particularly effective for petroleum compounds and soluble or volatile compounds. Natural bacteria consume the individual components that make up the most common petroleum contaminants. In complex petroleum mixtures, components that are not consumed or are very recalcitrant, generally are also less bioavailable. The rate at which microbes degrade organic compounds depends on a variety of factors. Some of the more important ones include temperature; moisture; pH; oxygen availability; active surface area; the presence or absence of other chemical compounds which may act as nutrients, stimulants, toxins, or retardants; and competition from other bacterial species. Soluble materials disperse as ground water moves through the system, and volatile materials evaporate. Contaminants exposed to the surface are subject to photo-oxidation and ultraviolet degradation. Physical degradation may also play a role for contaminants at the surface as compaction or freeze-thaw action affect active surface area, particle size, and aeration.

C) Monitoring ground water across the site and down gradient to assess degradation and migration of diesel range petroleum contamination until the state cleanup level of 1,000 µg/L is achieved.

Ground water sampling will be conducted to monitor petroleum degradation and migration. Ground water monitoring will be conducted in a phased manner starting on a semiannual basis. In conjunction with historic data, if a clear decline in contamination can be demonstrated, and that decline is consistent with current projections, sampling may be reduced to annual, biannual and eventually longer terms as negotiated at that time. The point of compliance will be throughout the plume. It is estimated that ground water cleanup levels can be achieved in a 2-year time frame. If monitoring indicates this remedy will not attain cleanup levels within a reasonable time frame, which shall not exceed 30 years, the need for remedial action will be reevaluated by the Air Force, EPA, and Ecology.

The degradation of soil contamination will be evaluated at the five year review. The state cleanup standard for petroleum in soil is 200 mg/kg. The point of compliance will be throughout the entire site. It is estimated that soil cleanup levels can be achieved in a 4-year time frame.

10.5 DEEP CREEK STEAM PLANT, BUILDING 1350 (PS-7)

The goals of the remedial action at PS-7 are to remediate ground water to state cleanup levels and to remediate soil to state cleanup. The selected remedy for soil is Institutional Controls and for ground water is Institutional Controls and Monitoring. The Air Force believes institutional

controls and institutional controls and monitoring provide the best balance of trade-offs with respect to the evaluation criteria (see also Sections 9.7.10 and 9.8.10). These remedies consist of the following elements:

- Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities;
- Allow natural attenuation to reduce the concentration of petroleum contamination; and
- Monitoring ground water across the site and down gradient to assess degradation and migration of diesel range petroleum contamination until the state cleanup level of 1,000 $\mu\text{g/L}$ is achieved.

The estimated costs associated with these remedies are tabulated as shown.

PS-7	SOIL	GROUND WATER
	INSTITUTIONAL CONTROLS	INSTITUTIONAL CONTROLS AND MONITORING
Capital Costs	\$14,500	\$118,027
Annual Operation and Maintenance Costs	\$0	\$1,300
Net Present Value	\$14,500	\$134,232

The following paragraphs present specific components of these remedies:

- A) Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities.

Institutional controls already in place require a Work Clearance Permit before intrusive activities are conducted. Personnel requesting intrusive access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. In the event of base closure, the Air Force, in conjunction with EPA and Ecology, will evaluate the need for additional site activities relative to the Community Environmental Response Facilitation Act.

- B) Allow natural attenuation to reduce the concentration of petroleum contamination.

Natural attenuation includes a number of components that collectively contribute to the reduction in contamination. It is particularly effective for petroleum compounds and soluble or volatile compounds. Natural bacteria consume the individual components that make up the most common petroleum contaminants. In complex petroleum mixtures, components that are not consumed or are very recalcitrant, generally are also less bioavailable. The rate at which microbes degrade organic compounds depends on a variety of factors. Some of the more important ones include temperature; moisture; pH; oxygen availability; active surface area; the

presence or absence of other chemical compounds which may act as nutrients, stimulants, toxins, or retardants; and competition from other bacterial species. Soluble materials disperse as ground water moves through the system, and volatile materials evaporate. Contaminants exposed to the surface are subject to photo-oxidation and ultraviolet degradation. Physical degradation may also play a role for contaminants at the surface as compaction or freeze-thaw action affect active surface area, particle size, and aeration.

- C) Monitoring ground water across the site and down gradient to assess degradation and migration of diesel range petroleum contamination until the state cleanup level of 1,000 $\mu\text{g/L}$ is achieved.

Ground water sampling will be conducted to monitor petroleum degradation and migration. Ground water monitoring will be conducted in a phased manner starting on a semiannual basis. In conjunction with historic data, if a clear decline in contamination can be demonstrated, and that decline is consistent with current projections, sampling may be reduced to annual, biannual and eventually longer terms as negotiated at that time. The point of compliance will be throughout the plume. It is estimated that ground water cleanup levels can be achieved in a 3-year time frame. If monitoring indicates this remedy will not attain cleanup levels within a reasonable time frame, which shall not exceed 30 years, the need for remedial action will be reevaluated by the Air Force, EPA, and Ecology.

The degradation of soil contamination will be evaluated at the five year review. The state cleanup standard for petroleum in soil is 200 mg/kg. The point of compliance will be throughout the entire site. It is estimated that soil cleanup levels can be achieved in a 3-year time frame.

10.6 FUEL TRUCK MAINTENANCE FACILITY, BUILDING 1060 (PS-10)

The goal of the remedial action at PS-10 is to remediate soil to state cleanup levels. Contaminated ground water will be addressed as part of the Priority 3 Operable Unit. The selected remedies are Excavation and Offsite Disposal, and Institutional Controls and Monitoring. The Air Force believes excavation and offsite disposal, and institutional controls and monitoring provide the best balance of trade-offs with respect to the evaluation criteria (see also Section 9.9.10). These remedies consists of the following elements:

- Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities;
- Excavation and offsite disposal of approximately 67 cubic yards of TCE contaminated soils. Pre-disposal treatment of soil includes high temperature incineration. The excavation will be backfilled with clean soil and graded;
- Allow natural attenuation to reduce the concentration of petroleum contamination; and

- Monitoring natural degradation of diesel range petroleum contamination in site soil until the contamination level decreases below the state cleanup level of 200 mg/kg.

The estimated costs associated with these remedies are tabulated as shown:

PS-10	SOIL (TCE)	SOIL (PETROLEUM)
	EXCAVATION AND OFFSITE DISPOSAL	INSTITUTIONAL CONTROLS AND MONITORING
Capital Costs	\$217,825	\$113,849
Annual Operation and Maintenance Costs	\$0	\$1,300
Net Present Value	\$356,780	\$125,182

The following paragraphs present specific components of these remedies:

- A) Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities.

Institutional controls already in place require a Work Clearance Permit before intrusive activities are conducted. The site is located adjacent to the flightline, and only Air Force personnel and authorized contractors can gain access. Personnel requesting intrusive site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. In the event of base closure, the Air Force, in conjunction with EPA and Ecology, will evaluate the need for additional site activities relative to the Community Environmental Response Facilitation Act.

- B) Excavation and offsite disposal of approximately 67 cubic yards of TCE contaminated soils. Pre-disposal treatment of soil includes high temperature incineration. The excavation will be backfilled with clean soil and graded.

Approximately 67 cubic yards of TCE contaminated soil will be excavated, treated at an offsite high temperature incinerator, and landfilled. In order to meet LDRs, TCE contamination must be reduced to 6.0 mg/kg before landfilling. Incineration is capable of meeting that requirement and is the BDAT. Soil sampling will confirm all soil exceeding the MTCA Method B cleanup level for residential use, based on direct contact, of 91 mg/kg will be removed from PS-10 and treated. The point of compliance will be throughout the site from the ground surface to 15 feet below the ground surface. It is estimated the cleanup action can be completed in a 1-year time frame.

- C) Allow natural attenuation to reduce the concentration of petroleum contamination.

Natural attenuation includes a number of components that collectively contribute to the reduction in contamination. It is particularly effective for petroleum compounds and soluble or volatile compounds. Natural bacteria consume the individual components that make up the most

common petroleum contaminants. In complex petroleum mixtures, components that are not consumed or are very recalcitrant, generally are also less bioavailable. The rate at which microbes degrade organic compounds depends on a variety of factors. Some of the more important ones include temperature; moisture; pH; oxygen availability; active surface area; the presence or absence of other chemical compounds which may act as nutrients, stimulants, toxins, or retardants; and competition from other bacterial species. Soluble materials disperse as ground water moves through the system, and volatile materials evaporate. Contaminants exposed to the surface are subject to photo-oxidation and ultraviolet degradation. Physical degradation may also play a role for contaminants at the surface as compaction or freeze-thaw action affect active surface area, particle size, and aeration.

- D) Monitoring natural degradation of diesel range petroleum contamination in site soil until the contamination level decreases below the state cleanup level of 200 mg/kg.

Soil sampling will be conducted to monitor petroleum degradation. Soil monitoring will be conducted in a phased manner starting on a semiannual basis. In conjunction with historic data, if a clear decline in contamination can be demonstrated, and that decline is consistent with current projections, sampling may be reduced to annual, biannual and eventually longer terms as negotiated at that time. The point of compliance will be throughout the site. It is estimated that soil cleanup levels can be achieved in a 4-year time frame. If monitoring indicates this remedy will not attain cleanup levels within a reasonable time frame, which shall not exceed 30 years, the need for remedial action will be reevaluated by the Air Force, EPA, and Ecology.

10.7 FORMER AIRCRAFT RECLAMATION YARD AT WHERRY HOUSING (SW-11)

The Air Force has determined no further remedial action is necessary at site SW-11 to ensure protection of human health and the environment. This decision is based on the results of the human health risk assessment, which determined conditions at the site posed no unacceptable chemical risks to human health or the environment. The Air Force will consider planting and maintaining a vegetative cap to mitigate physical hazards associated with buried metallic debris.

10.8 FORMER FIRE TRAINING AREA (FT-2)

The goals of the remedial actions at FT-2 are to remediate ground water to state cleanup levels and to remediate soil to state cleanup levels that are protective of ground water. The selected remedy for both soil and ground water is Institutional Controls and Monitoring. The Air Force believes institutional controls and monitoring provides the best balance of trade-offs with respect to the evaluation criteria (see also Sections 9.10.10 and 9.11.10). These remedies consist of the following elements:

- Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities;

- Allow natural attenuation to reduce the concentration of petroleum contamination; and
- Monitoring site soil and ground water and down gradient ground water to assess degradation and migration of diesel range petroleum contamination until state cleanup levels of 200 mg/kg and 1,000 µg/L, respectively, are achieved.

The estimated costs associated with these remedies are tabulated as shown.

FT-2	SOIL	GROUND WATER
	INSTITUTIONAL CONTROLS AND MONITORING	INSTITUTIONAL CONTROLS AND MONITORING
Capital Costs	\$113,021	\$117,833
Annual Operation and Maintenance Costs	\$1,300	\$1,300
Net Present Value	\$122,511	\$134,461

The following paragraphs present specific components of these remedies:

- A) Maintaining institutional controls requiring a Work Clearance Permit for intrusive activities.

Institutional controls already in place require a Work Clearance Permit for intrusive activities. The site is located adjacent to the flightline, and only Air Force personnel or authorized contractors can gain access. Personnel requesting intrusive site access will be warned about site conditions and will be required to take appropriate health and safety precautions to avoid exposure to contaminants. In the event of base closure, the Air Force, in conjunction with EPA and Ecology, will evaluate the need for additional site activities relative to the Community Environmental Response Facilitation Act.

- B) Allow natural attenuation to reduce the concentration of petroleum contamination.

Natural attenuation includes a number of components that collectively contribute to the reduction in contamination. It is particularly effective for petroleum compounds and soluble or volatile compounds. Natural bacteria consume the individual components that make up the most common petroleum contaminants. In complex petroleum mixtures, components that are not consumed or are very recalcitrant, generally are also less bioavailable. The rate at which microbes degrade organic compounds depends on a variety of factors. Some of the more important ones include temperature; moisture; pH; oxygen availability; active surface area; the presence or absence of other chemical compounds which may act as nutrients, stimulants, toxins, or retardants; and competition from other bacterial species. Soluble materials disperse as ground water moves through the system, and volatile materials evaporate. Contaminants exposed to the surface are subject to photo-oxidation and ultraviolet degradation. Physical degradation may also play a role for contaminants at the surface as compaction or freeze-thaw action affect active surface area, particle size, and aeration.

- C) Monitoring site soil and ground water and down gradient ground water to assess degradation and migration of diesel range petroleum contamination until state cleanup levels of 200 mg/kg and 1,000 μ g/L, respectively, are achieved.

Soil and ground water sampling will be conducted to monitor petroleum contamination degradation and migration. Soil and ground water monitoring will be conducted in a phased manner starting on a semiannual basis. In conjunction with historic data, if a clear decline in contamination can be demonstrated, and that decline is consistent with current projections, sampling may be reduced to annual, biannual, and eventually longer terms as negotiated at that time. For both soil and ground water, the points of compliance will be throughout the site and plume, respectively. It is estimated that the soil and ground water cleanup levels can be achieved in 4-year and 5-year time frames, respectively. If monitoring indicates this remedy will not attain cleanup levels within a reasonable time frame, which shall not exceed 30 years, the need for remedial action will be reevaluated by the Air Force, EPA, and Ecology.

11.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs, be cost effective, and utilize permanent solution and alternative technologies or resource recovery technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that employ treatment to significantly and permanently reduce the volume, toxicity, or mobility of hazardous wastes.

A range of cleanup alternatives for each site was initially identified in the feasibility study. These alternatives were screened by comparing effectiveness, implementability, and cost. The surviving alternatives were subjected to a detailed analysis to arrive at the selected remedies.

Remedies selected for the sites presented in this ROD are Institutional Controls; Institutional Controls and Monitoring; Open System Bioventing; and Excavation followed by Incineration and Off-Site Disposal. All selected remedies are protective of human health and the environment and comply with ARARs. The principal contaminants at these sites are petroleum fuels variously occurring in soil and ground water along with TCE in soil at PS-10 and benzene in ground water at PS-1.

Institutional controls is the selected remedy for soil contamination at PS-5 and PS-7 and for contamination at IS-3. Institutional controls and monitoring is the remedy selected for soils at sites IS-4 and FT-2, for petroleum contaminated soil at PS-10, and for ground water at sites PS-1, PS-5, PS-7, and FT-2. Open system bioventing is the selected remedy for petroleum contaminated soil at PS-1. Excavation followed by incineration and off-site disposal is the remedy selected for TCE contaminated soils at PS-1. No further action is recommended at SW-11.

At IS-3, the selected remedy is Institutional Controls. This selection is based on the results of the human health risk assessment, which determined that conditions at the site pose no unacceptable risks to human health. When Building 2150 is demolished, underlying soil will be assessed for PCBs and remediated as necessary.

The selected remedy for soil contamination at IS-4 is Institutional Controls and Monitoring. This remedy was selected because site geology appears to limit migration to ground water, there are no difficulties in implementation, and it is cost effective. Monitoring will identify when degradation has reached a point where soil petroleum concentrations are below the state cleanup standard.

The selected remedy for soil and ground water contamination at FT-2 is Institutional Controls and Monitoring. This remedy was selected because of its short and long term effectiveness, ease of implementation and low cost. Monitoring will identify when degradation has reached a point where soil and ground water petroleum concentrations are below the state cleanup standards.

Institutional Controls is the remedy selected for vadose zone soil contamination at sites PS-5 and PS-7. This remedy involves no active treatment for contaminated media and relies on remediation through natural degradation. This remedy was selected because of the relatively low

cancer risk and noncancer hazard posed by these sites, and because the contamination is buried in the vadose zone where it is unlikely to migrate. At each of these sites ground water monitoring will be conducted to confirm contaminants of concern are not migrating off-site.

The selected remedy for ground water remediation at PS-5 and PS-7 is Institutional Controls and Monitoring. This remedy was selected because the principal source has been removed (thus reducing the risk of migration). It is also easily implemented, and cost effective.

The selected remedy for soil remediation at PS-1 is Open System Bioventing. The selected remedy for ground water is Institutional Controls and Monitoring. Since the Air Force has already established a pilot scale bioventing treatment system at the site, and it is working well, it is logical to expand the pilot system to remediate soils at this location. For ground water, institutional controls and monitoring is the selected remedy because site geology appears to limit migration. Also the site is operational, which militates against the implementation of active remedies. Moreover the cost of active remedies like pump and treat systems is prohibitively high due to the large volume of water that would have to be treated.

Two remedies were selected for soil at PS-10. For TCE contaminated soil the selected remedy is Excavation and Off-site Disposal. For petroleum contaminated soil the selected remedy is Institutional Controls and Monitoring. For the TCE contaminated soils the remedy was selected because it is the only remedy that meets BDAT for spent solvents required by the LDRs, and is fully protective of human health and the environment. For petroleum contaminated soils this remedy was selected because the contamination is widely underlain by a dry vadose zone in which migration is unlikely. In addition, the remedy can be implemented easily, and is cost effective.

The Air Force has determined no further remedial action is necessary at site SW-11 to ensure protection of human health and the environment. This decision is based on the results of the human health risk assessment, which determined conditions at the site posed no unacceptable chemical risks to human health or the environment.

11.1 PROTECTIVENESS OF HUMAN HEALTH AND THE ENVIRONMENT

The following sections describe by site how the selected remedies meet the statutory requirement to be protective of human health and the environment.

11.1.1 Site IS-3

For site IS-3, current risk under the Air Force Personnel/Contractor scenario is principally due to direct exposure to PCB-1254 in sump sediments and ingestion of PCB-1242 in sump water. The risk associated with exposure to PCB-1254 in sump sediments is 3×10^{-5} and the risk associated with ingestion of sump water containing PCB-1242 is 6×10^{-6} . The cumulative risk for exposure to sump sediments and water is 4×10^{-5} , which is within the acceptable range. The current hazard associated with exposure to sump sediments under the same scenario is principally due to exposure to bis(2-ethylhexyl)phthalate. That hazard is 0.0002, which is below the screening

threshold of 1.0. The hazard associated with exposure to sump water is not quantifiable because the EPA has not published a reference dose for oral exposures to PCBs. All risks and hazards calculated for site IS-3 are based on RME assumptions. If contaminants leaked to the subsurface soil or ground water they would be diluted and the associated risk and hazard would be reduced. The selected remedy will not affect the risk or hazard associated with direct contact with sump contents. The remedial investigation, however, concluded no complete exposure pathways exists because the building is locked and is no longer used. Therefore, the selected remedy, institutional controls, will be protective of human health by preventing exposure to contaminants. Prior to demolition of Building 2150, sump water and sediments will be removed and disposed of in accordance with state and federal regulations.

11.1.2 Site IS-4

For site IS-4, current values of risk, based on RME assumptions, under the Air Force Personnel/Contractor scenario can be calculated only for exposure to ground water. Ground water contamination will be investigated under the Priority 3 Operable Unit. The remedy for this site will not affect ground water contamination because the source of ground water contamination is up gradient from this site. As a result, the risk for ground water ingestion at this site, 3×10^{-5} , will not change, and will continue to make up the bulk of the cumulative risk, 3×10^{-5} , for this site. Hazard associated with exposure to site soil under the same scenario is 0.4 and is due to ingestion of manganese and petroleum. The soil exposure hazard is at an acceptable level. Soils will be remediated, and total site risk and hazard will be reduced, but it is not possible to quantify the decrease in risk from soil remediation. The current cumulative hazard value, slightly over eight, under the same scenario is principally due to manganese in ground water which yields a hazard value of eight. As stated above, the selected remedy does not affect ground water, and as a result, this value will not change. These values do not include risk or hazard related to site surface water because contamination in surface water is not related to this site. It was, nevertheless, evaluated in the RI and is presented in the tables in Appendix A, raising the cumulative risk to 4×10^{-5} , and cumulative hazard to nine.

The remaining contaminated soil is either beneath concrete and asphalt pavement or beneath several feet of clean fill. Currently, IS-4 is an inactive engine test facility located adjacent to the flightline. Development of the site for residential use is remote. Development of IS-4 for industrial use is, to a lesser degree, also unlikely.

Concentrations of diesel range petroleum residues in soil currently exceeds state standards. Migration of these residues to ground water is not expected because the site is located in a low permeability clay basin, limiting the possibility of contaminant migration from site soil. Soil sampling will establish a trend in contamination levels to evaluate whether they are decreasing and whether the cleanup levels will be achieved through natural biodegradation within a reasonable period of time. Furthermore, the soil monitoring program along with the scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

11.1.3. Site PS-1

For Site PS-1, current risks, based on RME assumptions, under the Air Force Personnel/Contractor scenario are principally due to ingestion of benzene and arsenic contaminated groundwater and round up to a cumulative risk of 1×10^{-3} . This calculation is significantly influenced by the maximum concentration of benzene detected in one well. The risk posed to Air Force Personnel/Contractors by the average concentration of benzene in groundwater is 5×10^{-6} , which is within the acceptable risk range. The cumulative risk posed by average concentrations of all the COCs in groundwater to the same receptor group is 6×10^{-6} , also within the acceptable risk range. The selected remedy for groundwater at PS-1 is Institutional Controls and Monitoring. This action will be protective of human health and the environment by preventing exposure to groundwater and determining whether the COC concentrations decrease. The selected remedy, bioventing, for soils at PS-1 will reduce concentrations of benzene in soils, which will reduce the potential for migration of benzene to groundwater.

Petroleum contamination in soil currently exceeds state standards. Contamination was not reported below the upper 2-feet of a clay layer observed site-wide beneath PS-1. Migration to confined ground water is not expected because this clay layer limits the possibility of petroleum contamination vertically migrating from site soil. Bioventing, the selected remedy, will enhance natural biodegradation of petroleum in the soil. Soil sampling will be used to evaluate the effectiveness of the selected remedy and whether the cleanup levels can be achieved with open system bioventing within a reasonable period of time. During remediation, human exposure will be limited by institutional controls which require a permit to conduct intrusive activities. Furthermore, the soil monitoring program along with the scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

Petroleum concentrations in ground water currently exceed state cleanup standards. Sampling of down gradient monitoring wells indicates contaminants are not migrating off site. The selected remedy, institutional controls and monitoring, will rely on natural biodegradation to reduce petroleum and benzene concentrations to below state cleanup levels.

Arsenic and manganese concentrations in ground water are expected drop in parallel with petroleum hydrocarbon concentrations. Manganese is more soluble under reducing conditions. The effect of petroleum or other organic material leads the environments to become more reducing. As the organic materials are remediated, the environment returns to oxidizing conditions. These changes lead to variation in the amount of dissolved manganese in ground water and the corresponding redistribution of manganese in soils. Under these conditions arsenic behaves similarly. A complete discussion of this process is found in the remedial investigation report. Ground water sampling will be used to confirm biodegradation will reduce contaminant levels within a reasonable time frame. Human exposure to contaminants will be limited by the same institutional controls discussed in the soil section. Furthermore, the ground water monitoring program along with a scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

11.1.4 Site PS-5

For site PS-5, current risk and hazard, based on RME assumptions, under the residential exposure scenario can be calculated only for ground water exposure. Soils will be remediated, and total risk and hazard will be reduced, but it is not possible to quantify the decrease in risk from soil remediation. For site PS-5, current calculable risks and hazards under the residential exposure scenario are principally due to ingestion of manganese and arsenic contaminated ground water and round up to values equivalent to the site cumulative values of 1×10^{-3} for risk and 30 for hazard. The selected remedy should reduce cumulative site risk to a value ranging from 1×10^{-5} to 1×10^{-6} , depending on the degree to which arsenic is remediated. The selected remedy should reduce the cumulative site hazard to approximately 0.3.

Petroleum concentrations in soil currently exceeds state cleanup levels. Institutional controls will limit exposure to contaminated soil while petroleum contamination naturally biodegrades. Most contaminated soil remaining at the site lies beneath several feet of clean fill, so exposure is likely only during intrusive activities. Institutional controls already in place require a permit for intrusive activities. The scheduled five year review will evaluate contamination migration tendencies and degradation, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

Petroleum concentrations in site ground water exceed state cleanup standards. The selected remedy, institutional controls and monitoring will rely on natural biodegradation to reduce petroleum concentrations to below the state cleanup level.

Arsenic and manganese concentrations in ground water are expected drop in parallel with petroleum hydrocarbon concentrations. Manganese is more soluble under reducing conditions. The effect of petroleum or other organic material leads the environments to become more reducing. As the organic materials are remediated, the environment returns to oxidizing conditions. These changes lead to variation in the amount of dissolved manganese in ground water and the corresponding redistribution of manganese in soils. Under these conditions arsenic behaves similarly. A complete discussion of this process is found in the Remedial Investigation report. Ground water sampling will be used to confirm biodegradation will reduce contaminant levels within a reasonable time frame. Human exposure to contaminants will be limited by the same institutional controls discussed in the soil section. Furthermore, the ground water monitoring program along with a scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

11.1.5 Site PS-7

For site PS-7, current risk and hazard, based on RME assumptions, under the Air Force Personnel/Contractor scenario can be calculated only for ground water exposure because soil contamination is due to a petroleum mixture. Soils will be remediated, and total risk and hazard will be reduced, but it is not possible to quantify the decrease in risk from soil remediation. For site PS-7, current calculable risks and hazards under the Air Force Personnel/Contractor scenario are principally due to ingestion of chloroform and bromodichloromethane contaminated ground

water (both contaminants are likely to have been caused by lawn irrigation) and round up to 3×10^{-7} for risk and 4×10^{-3} for hazard. Neither of these values exceeds any screening thresholds now and are expected to only decrease in time.

Petroleum concentrations in soil currently exceed state cleanup standards. Institutional controls will limit exposure to contaminated soil while petroleum contamination naturally biodegrades. Most remaining contaminated soil lies beneath several feet of clean fill or beneath Building 1350, so exposure is likely only during soil excavation. Institutional controls require a permit for intrusive activities. The scheduled five year review will evaluate contamination migration tendencies and degradation, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

Petroleum concentrations in ground water exceed state cleanup standards. The selected remedy, institutional controls and monitoring will rely on natural biodegradation to reduce concentrations of petroleum to below the state cleanup level and reduce the risk associated with chloroform. Ground water sampling will be used to confirm biodegradation will reduce contaminant levels within a reasonable time frame. Human exposure to contaminants will be limited by the same institutional controls discussed in the soil section. Furthermore, the ground water monitoring program along with a scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

11.1.6 Site PS-10

For site PS-10, current hazard and risk, based on RME assumptions, under the Air Force Personnel/Contractor scenario determined for soil are presented in this ROD. Current hazard under the same scenario are principally due to manganese and thallium in soils creating a hazard that rounds up to 0.2, which is below the screening threshold. The selected remedy should reduce the cumulative site hazard even further. Current risk under the same scenario are principally due to TCE in soil creating a risk that rounds up to 1×10^{-6} , which is within the acceptable range. The selected remedy should reduce the cumulative site risk to approximately 1×10^{-7} . These values and remedies do not include or affect risk or hazard related to site ground water, because contamination in ground water will be evaluated under the Priority 3 Operable Unit. It was, nevertheless, evaluated in the RI and is presented in the tables in Appendix A.

The selected remedy for TCE contaminated soil, excavation, incineration, and landfilling, will prevent exposure to contamination by removing it from the site and incinerating it. Soil samples will be collected to assure all TCE contaminated soil above action levels is removed.

Petroleum contamination in soil currently exceeds state standards. Institutional controls and monitoring, the selected remedy, will rely on natural biodegradation to reduce concentrations of petroleum to below the state cleanup level. Soil sampling will be used to evaluate the effectiveness of the selected remedy and whether the cleanup levels can be achieved through natural biodegradation within a reasonable period of time. During remediation, human exposure will be limited by institutional controls which require a permit to conduct intrusive activities.

Furthermore, the soil and ground water monitoring programs along with a scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

11.1.7 Site SW-11

For site SW-11, current risk and hazard, based on RME assumptions, under the Air Force Personnel/Contractor scenario, are 2×10^{-6} and 0.09 respectively, both of which are in or below the acceptable range. This indicates there are no risk based contaminants of concern. As a result there is no remedial action proposed for the site. In time, the conditions are expected to only improve. The Air Force is considering covering the site with a vegetated cap to reduce the chance of injury from debris near the surface.

11.1.8 Site FT-2

For site FT-2, current risk, based on RME assumptions, under the Air Force Personnel/Contractor scenario is principally due to ingestion of 1,1-dichloroethene and carbon tetrachloride contaminated ground water and rounds up to 2×10^{-6} , essentially the same value as the cumulative risk for the site. The selected remedy should reduce this value to an amount less than 1×10^{-6} , reducing cumulative site risk to a similar amount. Current hazards under the same scenario are principally due to ingestion of manganese contaminated ground water and round up to 4. The selected remedy should reduce the cumulative site hazard to approximately 0.3. Calculable site values for risk and hazard related to soil are confined to ingestion and amount to 1×10^{-8} for risk and 1×10^{-3} for hazard, both of which are below screening thresholds and contribute insignificantly to site cumulative risk or hazard.

Petroleum concentrations in soil currently exceed state cleanup levels. The selected remedy, institutional controls and monitoring, will limit exposure to contaminated soil while petroleum contamination naturally biodegrades. Institutional controls already in place require a permit which ensures appropriate health and safety precautions for any personnel involved in intrusive activities. Soil sampling will establish a trend in contamination levels to evaluate whether they are decreasing and whether the cleanup levels can be achieved through natural biodegradation within a reasonable period of time. Furthermore, the soil monitoring program along with the scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

Manganese concentrations in ground water are expected drop in parallel with petroleum hydrocarbon concentrations. Manganese is more soluble under reducing conditions. The effect of petroleum or other organic material leads the environments to become more reducing. As the organic materials are remediated, the environment returns to oxidizing conditions. These changes lead to variation in the amount of dissolved manganese in ground water and the corresponding redistribution of manganese in soils. A complete discussion of this process is found in the Remedial Investigation report.

Petroleum concentrations in site ground water exceed state cleanup standards. The selected remedy, institutional controls and monitoring, will rely on natural biodegradation to reduce concentrations of petroleum to below the state cleanup level. Ground water sampling will be used to confirm biodegradation will reduce contaminant levels within a reasonable time frame. Human exposure to contaminants will be limited by the same institutional controls discussed in the soil section. Furthermore, the ground water monitoring program along with a scheduled five year review will evaluate contamination migration tendencies, satisfy the CERCLA requirement for contaminants remaining on site, and will determine if the remedy remains protective of human health and the environment.

11.2 COMPLIANCE WITH ARARS

The selected remedies will comply with the listed federal and state ARARs. No waiver of any ARAR is being sought or invoked for any component of the selected remedies. The ARARs identified for the on-Base Priority 2 sites are listed in the following sections.

11.2.1 Chemical-Specific ARARs

The following chemical specific ARARs were identified for the remedial actions selected in this document:

- MTCA Method A (Chapter 173-340 WAC, subsection 704). Method A cleanup levels are applicable for establishing soil and ground water cleanup levels.
- MTCA Method B (Chapter 173-340 WAC, subsection 705). Method B risk-based cleanup levels are applicable for establishing soil and ground water cleanup levels.
- SDWA (40 CFR Part 141, Subpart B). Provides MCLs for public drinking water supplies. MCLs established for the SDWA are relevant and appropriate for setting ground water cleanup levels.
- MTCA Ground Water Cleanup Standards (Chapter 173-340 WAC, subsection 720). Used to establish ground water cleanup levels.
- MTCA General Soil Cleanup Standards (Chapter 173-340 WAC, subsection 740). Used to establish soil cleanup levels at nonindustrial sites.
- MTCA Soil Cleanup Standards for Industrial Sites (Chapter 173-340 WAC, subsection 745). Used to establish soil cleanup levels where the department has determined that industrial site use represents the reasonable maximum exposure.

11.2.2 Action-Specific ARARs

The following action specific ARARs were identified for the remedial actions selected in this document:

- TSCA (40 CFR Section 761.60(a)(4)). Applicable to the storage and disposal of PCB-contaminated products and wastes. This ARAR applied only to the PCB-contamination observed at Site IS-3.
- RCRA Subtitle C (40 CFR 261 and 262). Establishes standards for the identification of hazardous waste and for generators of hazardous wastes, specifically the treatment, storage, and shipping of wastes. LDRs under RCRA (40 CFR 268) are applicable to disposal of hazardous wastes generated during investigations and hazardous wastes excavated and removed during remedial actions.
- Dangerous Waste Regulations (Chapter 173-303 WAC). Applicable for onsite treatment, storage, or disposal of dangerous or hazardous wastes generated during remedial actions.
- Washington State Standards for Solid Waste Handling and Disposal (173-304 WAC). Sets minimum functional standards for the proper handling and disposal of solid waste materials.
- Minimum Standards for Construction and Maintenance of Wells (Chapter 173-360 WAC). Provides applicable regulations for the location, design, construction, and abandonment of water supply and resource protection wells.
- Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC). Requires the use of Best Available Control Technology for new sources of toxic air pollutants. Pursuant to CERCLA, all air emissions associated with the remedial actions will comply with the substantive requirements of Chapter 173-460 WAC as implemented by the Spokane County Air Pollution Control Authority. The ambient impact of emissions of toxic air contaminants from the bioventing system at PS-1 will be evaluated against Acceptable Source Impact Levels.
- Hazardous Materials Transportation Act (49 USC 1801-1803 and 49 CFR Parts 171 and 172). Applicable for transportation of potentially hazardous materials, including field samples and investigation derived wastes.

11.2.3 Location-Specific ARARs

The following location specific ARAR was identified for the remedial actions selected in this document:

- Protection of Wetlands (40 CFR 6, Appendix A). Applicable to the protection of wetlands present in the ditch at Site IS-4.

11.2.4 Other Guidance

An additional guideline to be considered for remedial actions selected in this document is as follows:

- EPA OSWER (40 CFR 300.440), Revised Procedures for Planning and Implementing Offsite Response Actions, November 13, 1987. This rule provides procedures for offsite disposal of CERCLA wastes.

Guidance applicable to the performance of CERCLA response actions and considered when evaluating implementation and to a lesser extent cost includes:

- OSHA (29 CFR, 1900 Series). Applicable to ensure worker health and safety during any site action.

11.3 COST EFFECTIVENESS

The selected remedies are overall the most effective for their cost.

11.3.1 Site IS-3

Institutional controls provide the most cost effective means of preventing exposure to contaminated sediments in the sump.

11.3.2 Site IS-4

Contaminants, located beneath pavement and clean fill, are expected to naturally biodegrade. Therefore, institutional controls and monitoring provides the most cost effective remedy for this site.

11.3.3 Site PS-1

Bioventing is more cost effective than other soil treatment/disposal alternatives. Institutional controls and monitoring is the most cost effective alternative for monitoring and preventing exposure to ground water contamination. Specific ground water contaminants are expected to naturally biodegrade.

11.3.4 Site PS-5

Institutional controls is the most cost effective alternative for controlling exposure to subsurface soil contamination while petroleum naturally biodegrades. Similarly, institutional controls and monitoring is the most cost effective alternative for monitoring of natural biodegradation and preventing exposure to ground water contamination.

11.3.5 Site PS-7

Institutional controls is the most cost effective alternative for controlling exposure to subsurface soil contamination while petroleum naturally biodegrades. Similarly, institutional controls and monitoring is the most cost effective alternative for monitoring natural biodegradation and preventing exposure to ground water contamination.

11.3.6 Site PS-10

The net present value of excavation, incineration, and offsite disposal of TCE contaminated soil is high. It is, however, the BDAT under LDRs. For petroleum contaminated soil, institutional controls and monitoring is the most cost effective alternative. This alternative is protective of human health and meets ARARs.

11.3.7 Site SW-11

There are no chemical hazard contaminants of concern at this site. "No Action" is therefore the most appropriate and cost effective alternative.

11.3.8 Site FT-2

Institutional controls and monitoring is the most cost effective alternative for preventing exposure while soil and ground water contamination naturally biodegrades.

11.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT POSSIBLE

Many of the selected remedies make use of biodegradation processes that irreversibly destroy petroleum hydrocarbon contamination. Biodegradation irreversibly reduces the toxicity of petroleum hydrocarbons by reducing them into carbon dioxide, water, and nonhazardous fatty acids. Likewise, physical removal and incineration of TCE contaminated soil at PS-10 provides a permanent reduction in contaminant levels. For PS-1 soil, bioventing, an innovative technology which enhances natural biodegradation, is the selected remedy. With the exception of TCE contamination in PS-10 site soil, the contaminants of concern at all sites are biodegradable hydrocarbons.

Removal actions at IS-4, PS-5, and PS-7 have already eliminated most of the contaminated soil from these sites. Biodegradation is expected to irreversibly reduce the remaining petroleum hydrocarbons, thus eliminating a potential source of contamination to ground water. At site PS-10, excavation and incineration of TCE contaminated soil will permanently eradicate any continuing source of ground water contamination.

Bioventing is an effective, unobtrusive, low maintenance alternative for remediation petroleum hydrocarbons. It has been extensively tested, but is still considered innovative. Bioventing will be used to enhance biodegradation of petroleum contaminated soil at PS-1. Removal of soil contamination will eliminate the source of hydrocarbons to site ground water.

11.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy for site PS-1 soil satisfies the statutory preference for treatment by utilizing in place treatment as a primary method to permanently reduce toxicity of petroleum residue contamination in the environment.

The selected remedy for TCE contaminated soil at site PS-10 satisfies the statutory preference for treatment by using high temperature incineration to destroy contaminants.

The remaining selected remedies will rely on natural biodegradation to reduce toxicity of contaminants of concern.

12.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the on-base Priority 2 Sites was released for public comment on May 1, 1995. Public comments on the Priority 2 Sites Proposed Plan were evaluated at the end of the 30-day comment period, and it was determined no significant changes to the Proposed Plan were necessary. Preferred alternatives are now selected remedies.

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APPENDIX A

SUMMARY OF ANALYTICAL DATA AND RISK CALCULATIONS

TABLE A-1. CONCENTRATIONS OF THE CONTAMINANT OF CONCERN AT SITE IS-3

MEDIA	COC	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Sump Sediments	PCB (Aroclor-1254)	0.31 mg/kg	0.24 mg/kg (based on 1 sample and a duplicate)

**TABLE A-2. SUMMARY OF RESULTS OF NON-METAL ANALYSES FOR SEDIMENT
SAMPLES AT IS-3 COLLECTED DURING THE RI**

ANALYTE	NUMBER OF DETECTIONS/ANALYSES	MAXIMUM DETECTION (mg/kg)
PCB-1254 (SW8080)	2/2	0.31
VOC (SW8260)		
Toluene	1/1	0.14R
p-Cymene (p-Isopropyltoluene)	1/1	0.28R
1,4-Dichlorobenzene	1/1	1.6R
Ethylbenzene	1/1	0.32R
1,2,4-Trimethylbenzene	1/1	1.10R
1,3,5-Trimethylbenzene	1/1	0.73R
m,p-Xylene(s)	1/1	1.20R
o-Xylene	1/1	0.48R
SVOC (SW8270)		
bis(2-ethylhexyl)Phthalate	1/1	7.0
1,4-Dichlorobenzene	1/1	4.0

R = Data are rejected.

**TABLE A-3. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN
SEDIMENT AT IS-3**

CHEMICAL	SUMP SEDIMENTS (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS						
Aluminum	1,210	---	---	---	13,000	NO
Antimony	0.59	---	---	11	0.3	NO
Arsenic	1.6	1.4	0.04	8.2	13	NO
Barium	312	5,600	---	1,900	190	NO
Cadmium	2.7	40	---	27	0.43	NO
Calcium	4,250	---	---	---	8,800	NO
Chromium (VI) ^(h)	21.1J	400	---	140	15	NO
Copper	144	3,000	---	1,000	22	NO
Iron	5,520	---	---	---	34,000	NO
Lead	157	---	---	---	50	YES
Magnesium	1,080	---	---	---	53,000	NO
Manganese	32.4	400	---	3,800	670	NO
Mercury	1.37	24	---	8.2	0.05	NO
Nickel	6.2	1,600	---	550	13	NO
Potassium	268	---	---	---	2,500	NO
Silver	2.1	240	---	140	0.5	NO
Sodium	109	---	---	---	600	NO
Zinc	1,890	24,000	---	8,200	68	NO

**TABLE A-3. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN
SEDIMENT AT IS-3 (Continued)**

CHEMICAL	SUMP SEDIMENTS (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
ORGANICS						
p-Cymene	0.28R	---	---	---	---	YES
1,4-Dichlorobenzene	4.0	160	10	270	---	NO
Ethylbenzene	0.32R	8,000	---	2,700	---	NO
bis(2-Ethylhexyl) phthalate	7.0	7.1	4.6	550	---	YES
Polychlorinated biphenyl (PCB) 1254	0.31J	0.13	0.008	---	---	YES
Toluene	0.14R	16,000	---	5,500	---	NO
1,2,4-Trimethylbenzene	1.1R	---	---	---	---	YES
1,3,5-Trimethylbenzene	0.73R	---	---	---	---	YES
Xylenes	1.68R	160,000	---	55,000	---	NO

^(a) All Values rounded to two significant digits

^(b) The screening was conservatively performed on the maximum concentration detected over all depths analyzed. Chemicals detected in surface soil will be evaluated in the exposure assessment

^(c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria

^(d) Based on EPA Region 10 guidance (1991b), the soil RBSL for carcinogens is based on a 1×10^{-6} risk.

^(e) Based on EPA Region 10 guidance (1991b), the soil RBSL for noncarcinogens is based on a 0.1 hazard quotient.

^(f) High Normal Background Concentrations were calculated and referenced in SAIC (1991). There is no background data for organic chemicals. See text.

^(g) Potential chemicals of concern include metals that exceed (or do not have) the lowest criteria presented and exceed the background UTL as well as organic compounds that exceed (or do not have) the lowest criteria presented. Chemicals without an RBSL lack toxicity criteria. Based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement. Based on EPA Region 10 guidance (1991b), if chromium, cadmium, elemental mercury, or carcinogenic forms of nickel are present as contaminants of concern in soil, they should not be eliminated based on soil ingestion screening criteria. However, if concentrations are less than background, they will not be evaluated further.

^(h) Chromium detected in sediment samples was assumed to be hexavalent to maintain a conservative risk assessment approach.

--- = No Value.

COC = Contaminant of Concern

RBSL = Risk-Based Screening Level

TABLE A-4. RISK-BASED SCREENING LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN SUMP WATER AT IS-3

CHEMICAL	SUMP WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS							
Lead	30	15	---	---	---	20	YES
Zinc	140	---	4,800	---	1,100	40	NO
ORGANICS							
1,4-Dichlorobenzene	1.3	75	1.8	3.5	200	---	NO
bis(2-Ethylhexyl)phthalate	67	6	6.2	6.1	73	---	(h)
Polychlorinated biphenyl (PCB)-1242	0.21	0.5	0.014	0.01	---	---	YES
Toluene	8R	1,000	1,600	---	97	---	(h)
1,2,4-Trichlorobenzene	0.51	70	80	---	2.0		NO

(a) All values rounded to two significant digits.

(b) Federal Maximum Contaminant Levels (MCL) for drinking water

(c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria

(d) Based on EPA Region 10 guidance (1991b), the ground water RBSL for carcinogens is based on a 1×10^{-6} risk. RBSLs for volatile chemicals with an inhalation slope factor were calculated based on ingestion and inhalation of volatiles from ground water

(e) Based on EPA Region 10 guidance (1991b), the ground water RBSL for noncarcinogens is based on a 0.1 hazard quotient. RBSLs for volatile chemicals with inhalation reference doses were calculated based on ingestion and inhalation of volatiles from ground water

(f) High Normal Background Concentrations (HNBC) were calculated for ground water and referenced in SAIC (1991). There is no background for organic chemicals. HNBC referenced in this table for information purposes, it is unlikely that sump water is in direct communication with ground water and concentrations detected in sump water may be largely diluted if they contact ground water in the future

(g) Potential chemicals of concern include chemicals that exceed (or do not have) the lowest criteria presented and that exceed background. However, based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement

(h) Not chosen as a potential chemical of concern because presence is due to blank contamination. The concentration of bis(2-ethylhexyl)phthalate and toluene in the equipment blank was 17.0 and 1.0R, respectively

--- = No Value

COC = Contaminant of Concern

RBSL = Risk-Based Screening Level

**TABLE A-5. CONCENTRATION OF THE CONTAMINANT OF CONCERN
AT SITE IS-4**

MEDIUM	COC	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Soil	TPH-D (JP-4)	6,000 mg/kg	1,194 mg/kg

**TABLE A-6. SUMMARY OF PETROLEUM RESIDUE FIELD
SCREENING ANALYSES AT IS-4**

SCREENING SAMPLE NO.	DEPTH (feet bgs)	RESULTS OF SCREENING ANALYSES (mg/kg of petroleum residue)
H-1	2	100 - 200
H-2	2	10 - 50
H-3	3	10 - 50
H-4	1	10 - 50
H-5	3	10 - 50
H-6	1	200
H-7	2	500
H-8	4	50 - 100
H-9	4	<10
H-10	4	<10
H-11	3.5	1000
H-12	3.5	>1000
H-13	3	>1000
H-14	3	10 - 50
H-15	2.5	500
H-16	2.5	2000
H-17	2	200
H-18	4	50
H-19	2	500 - 1000
H-20	2	500 - 1000
H-21	2	100

**TABLE A-6. SUMMARY OF PETROLEUM RESIDUE FIELD
SCREENING ANALYSES AT IS-4 (Continued)**

SCREENING SAMPLE NO.	DEPTH (feet bgs)	RESULTS OF SCREENING ANALYSES (mg/kg of petroleum residue)
H-22	3	2000
H-23	3	1000
H-24	3	50
H-25	2	10
H-26	4	10
H-27	4	200
H-28	3	500
H-29	3	100
H-30	3	10
H-31	1.5	200 - 500
H-32	2.5	10
H-33	3	10 - 50
H-34	2	500
H-35	4	100
H-36	3	2000
H-37	4	2000

TABLE A-7. SUMMARY OF SOIL ANALYSES FOR THE TEST PIT AT IS-4^(a)

SAMPLE ID	DEPTH (feet)	VOC ^(b) SW8260 (mg/kg)	TOC SW9060 (mg/kg)	TPH ^(c) CA 8015 (mg/kg)	METALS ^(d) 6010 (mg/kg)
FAFB-IS-4-S09	3.0-3.5	0.0059UJ	N/A	Diesel 5U	N/A
FAFB-IS-4-S10	3.0-3.5	0.0059UJ	N/A	Diesel 5U	N/A
FAFB-IS-4-S11	3.5-4.0	0.0064UJ	N/A	Diesel 5U	N/A
FAFB-IS-4-S12	2.0-2.5	Isopropyltoluene 0.29J Naphthalene 0.68J m-,p-Xylene(s) 2.83 o-Xylene 1.05 1,3,5-Trimethylbenzene 7.6 1,2,4-Trimethylbenzene 11.0	N/A	Diesel 1,900	N/A
FAFB-IS-4-S13	3.0-3.5	Chloroform 0.0098J	N/A	Diesel 5U	N/A
FAFB-IS-4-S14	4.0-4.5	o-Xylene 0.0068 1,3,5 Trimethylbenzene 0.015J	N/A	Diesel 300	N/A
FAFB-IS-4-S15	3.0-3.5	Ethylbenzene 0.0062UJ m-,p-Xylene(s) 0.93J o-Xylene 0.0062UJ 1,3,5-Trimethylbenzene 1.4J 1,2,4-Trimethylbenzene 2.9J	N/A	Diesel 440	N/A
FAFB-IS-4-S16	2.5-3.0	0.0061UJ	N/A	Diesel 5U	N/A
FAFB-IS-4-S17(d) [FAFB-IS-4-S31, Duplicate]	4.0-4.5	m-,p-Xylene(s) 0.045J o-Xylene 0.021J 1,3,5-Trimethylbenzene 1.7J [1.4UJ]	1544 [N/A]	Diesel 1,800 [2,500]	Mg 5780 Ti 11.6 ^(e) Zn 70.1 [N/A]
FAFB-IS-4-S18	5.0-5.5	0.0065UJ	N/A	Diesel 5U	N/A
FAFB-IS-4-S19	3.5-4.0	0.0055UJ	542	Diesel 5U	N/A
FAFB-IS-4-S20	3.5-4.0	Ethylbenzene 12.1J m-,p-Xylene(s) 93.3J o-Xylene 31.8J n-Propyl Benzene 7.4J 1,3,5-Trimethylbenzene 42J 1,2,4-Trimethylbenzene 110J sec-Butylbenzene 5.6J	N/A	Diesel 4,900	N/A

TABLE A-7. SUMMARY OF SOIL ANALYSES FOR THE TEST PIT AT IS-4^(a) (Continued)

SAMPLE ID	DEPTH (feet)	VOC ^(b) SW8260 (mg/kg)	TOC SW9060 (mg/kg)	TPH ^(c) CA 8015 (mg/kg)	METALS ^(d) 6010 (mg/kg)
FAFB-IS-4-S25	3.6-3.8	0.0057UJ	146	Diesel 5U	N/A
FAFB-IS-4-S26	4.3-4.5	m-,p-Xylene(s) 3.2J Isopropyltoluene 1.3J 1,3,5-Trimethylbenzene 3.2J 1,2,4-Trimethylbenzene 8J sec-Butylbenzene 0.45J	N/A	Diesel 2,200	N/A
FAFB-IS-4-S27	3.2-3.3	Isopropyltoluene 6.0J Ethylbenzene 6.6J m-,p-Xylene(s) 13J o-Xylene 0.28J n-Propyl Benzene 6.6J 1,3,5-Trimethylbenzene 24J 1,2,4-Trimethylbenzene 73J	N/A	Diesel 4,800	N/A
FAFB-IS-4-S28	6.5-6.8	0.0056UJ	N/A	Diesel 5U	N/A
FAFB-IS-4-S29	2.0-2.5	m-,p-Xylene 0.79J o-Xylene 0.90J 1,3,5-Trimethylbenzene 8.7J 1,2,4-Trimethylbenzene 5.3J	N/A	Diesel 6,000	N/A
FAFB-IS-4-S30	3.2-3.5	m-,p-Xylene 10.0J o-Xylene 5.2J 1,3,5-Trimethylbenzene 9.9J 1,2,4-Trimethylbenzene 12J	N/A	Diesel 3,800	N/A

- (a) Several samples were analyzed by two separate analytical laboratories. Values presented are maximum detections or minimum detection limits.
- (b) Refer to Appendix H for complete analyte list and compound specific detection limits.
- (c) TPH analyses quantified to a JP-4 standard did not detect fuel constituents above the MDL of between 11 mg/kg to 13 mg/kg. All JP-4 analyses were qualified as estimated.
- (d) All metal analyses by ICP (SW6010) unless otherwise noted.
- (e) Thallium was not detected by Method 7840. The detection of thallium is, therefore, considered a result of analytical interference common to Method 6010.

N/A = Not Analyzed.

U = No compounds detected. The value listed is the detection limit of the analysis.

J = value is estimated.

TABLE A-8. RISK-BASED SCREENING LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN GROUND WATER AT IS-4

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS							
Aluminum	11,000	---	---	---	---	16,000	NO
Arsenic	11	50	0.05	0.05	1.1	2	YES
Barium	2,600	2,000	1,100	---	260	2,700	NO
Cadmium	21	5	8	---	1.8	---	YES
Calcium	69,000	---	---	---	---	---	NO
Chromium (VI) ^(h)	41	100	80	---	18	30	YES
Copper	35	1,300	590	---	140	30	NO
Iron	20,000	---	---	---	---	35,000	NO
Lead	91	15	---	---	---	20	YES
Magnesium	19,000	---	---	---	---	---	NO
Manganese	2,800	---	80	---	18	1,500	YES
Potassium	14,000	---	---	---	---	---	NO
Silver	11.0	50	48	---	18	5	NO
Sodium	26,000	---	---	---	---	---	NO
Vanadium	57	---	110	---	26	330	NO
Zinc	130	---	4,800	---	1,100	40	NO
ORGANICS							
Benzene	71	5	35	0.6	---	---	YES
Carbon tetrachloride	4.5	5	0.34	0.7	2.6	---	YES
Chloroform	2NJ						NO

TABLE A-8. RISK-BASED SCREENING LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN GROUND WATER AT IS-4 (Continued)

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
bis(2-Ethylhexyl)phthalate	22	6	6.2	6.1	73	---	YES ⁽ⁱ⁾
2,4-Dimethylphenol	18	---	320	---	73	---	NO
Dimethylphthalate	77	---	16,000	---	36,000	---	NO
Ethylbenzene	200	700	800	---	160	---	YES
2-Methylnaphthalene	13	---	---	---	---	---	YES
Naphthalene	13	---	320	---	150	---	NO
Toluene	180	1,000	1,600	---	97	---	YES
Total petroleum hydrocarbons	3.0	---	---	---	290 ^(j)	---	NO
Trichloroethene	1.0	5	4.0	2.5	26	---	NO
Xylenes (total)	3,200	10,000	16,000	---	80	---	YES

- (a) All values rounded to two significant digits.
- (b) Federal Maximum Contaminant Levels (MCL) for drinking water.
- (c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (1991b), the ground water RBSL for carcinogens is based on a 1×10^{-6} risk. RBSLs for volatile chemicals with an inhalation slope factor were calculated based on ingestion and inhalation of volatiles from ground water.
- (e) Based on EPA Region 10 guidance (1991b), the ground water RBSL for noncarcinogens is based on a 0.1 hazard quotient. RBSLs for volatile chemicals with inhalation reference doses were calculated based on ingestion and inhalation of volatiles from ground water.
- (f) High Normal Background Concentrations (HNBC) were calculated and referenced in SAIC (1991). There is no background for organic chemicals.
- (g) Potential chemicals of concern include chemicals that exceed (or do not have) the lowest criteria presented and that exceed background. However, based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.
- (h) To maintain a conservative risk assessment approach, chromium was assumed to be hexavalent.
- (i) Chosen as a potential chemical of concern; however, presence of this contaminant may be due to blank contamination.
- (j) The noncarcinogenic RBSL is based on a provisional oral reference dose for JP-4 (EPA 1992). JP-4 was used historically at IS-4.

--- = No Value
 COC = Contaminant of Concern
 RBSL = Risk-Based Screening Level

TABLE A-9. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN SOIL AT IS-4

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS						
Aluminum	14,000	---	---	---	13,000	NO
Antimony	8.1	---	---	11	0.3	NO
Arsenic	5.9	1.4	0.04	8.2	13	NO
Barium	200	5,600	---	1,900	190	NO
Cadmium	0.20	40	---	27	0.43	NO
Calcium	10,000	---	---	---	8,800	NO
Chromium (VI)	14	400	---	140	15	NO
Cobalt	21	---	---	---	14	YES
Copper	24	3,000	---	1,000	22	NO
Iron	58,000	---	---	---	34,000	NO
Lead	26	---	---	---	50	NO
Magnesium	5,700	---	---	---	53,000	NO
Manganese	1,500	400	---	3,800	670	YES
Mercury	0.43	24	---	8.2	0.05	NO
Nickel	23	1,600	---	550	13	NO
Potassium	2,500	---	---	---	2,500	NO
Sodium	1,300	---	---	---	600	NO
Vanadium	100	560	---	190	69	NO
Zinc	81	24,000	---	8,200	68	NO
ORGANICS						
sec-Butylbenzene	5.6	---	---	---	---	YES
Chloroform	0.01	160	10	270	---	NO

TABLE A-9. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN SOIL AT IS-4 (Continued)

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
Ethylbenzene	7.9	8,000	---	2,700	---	NO
p-Cymene	6.0	---	---	---	---	NO
Methylene Chloride	0.01	130	8.5	1,600	---	NO
Naphthalene	0.68	320	---	1,000	---	NO
n-Propylbenzene	7.4	---	---	---	---	YES
Total petroleum hydrocarbons	6,000	---	---	2,200 ^(h)	---	NO
1,2,4-Trimethylbenzene	110	---	---	---	---	YES
1,3,5-Trimethylbenzene	42	---	---	---	---	YES
Xylenes	110	160,000	---	55,000	---	NO

- (a) All Values rounded to two significant digits.
- (b) The screening was conservatively performed on the maximum concentration detected over all depths analyzed. Chemicals detected in soil will be evaluated in the exposure assessment.
- (c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (1991b), the soil RBSL for carcinogens is based on a 1×10^{-7} risk.
- (e) Based on EPA Region 10 guidance (1991b), the soil RBSL for noncarcinogens is based on a 0.1 hazard quotient.
- (f) High Normal Background Concentrations were calculated and referenced in SAIC (1991). There is no background data for organic chemicals. See text.
- (g) Potential chemicals of concern include metals that exceed (or do not have) the lowest criteria presented and exceed the background UTL as well as organic compounds that exceed (or do not have) the lowest criteria presented. Chemicals without an RBSL lack toxicity criteria. Based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement. Based on EPA Region 10 guidance (1991b), if chromium, cadmium, elemental mercury, or carcinogenic forms of nickel are present as contaminants of concern in soil, they should not be eliminated based on soil ingestion screening criteria. However, if concentrations are less than background, they will not be evaluated further.
- (h) The noncarcinogenic RBSL is based on a provisional oral reference dose for JP-4 (EPA 1992). JP-4 was used historically at IS-4.

--- = No Value.

COC = Contaminant of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-10. RISK-BASED SCREENING LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN SURFACE WATER AT IS-4

CHEMICAL	SURFACE WATER (µg/L) (a)					
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	POTENTIAL COC ^(f)
INORGANICS						
Arsenic	8.3	50	0.08	0.05	1.1	YES
Chromium (VI)	25	100	810	---	18	YES
Lead	9.8	15(g)	---	---	---	NO
Manganese	850	---	---	---	18	YES
Silver	11	50	15,600	---	18	NO
Zinc	68	---	16,500	---	1,100	NO

(a) All values rounded to two significant digits.

(b) Federal Maximum Contaminant Levels (MCL) for drinking water.

(c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. The values presented are based on ambient water quality criteria. The lower of two criteria was used (fresh water chronic versus ingestion of water and organisms).

(d) Based on EPA Region 10 guidance (1991b), the surface water RBSL for carcinogens is based on a 1×10^{-6} risk.

(e) Based on EPA Region 10 guidance (1991b), the surface water RBSL for noncarcinogens is based on a 0.1 hazard quotient.

(f) Potential chemicals of concern include chemicals that exceed (or do not have) the lowest criteria presented. However, based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.

(g) Action level for ground water tap samples (exceeded if one level of concentration in more than 10% of targeted tap samples is greater than the specified value (90th percentile)).

--- = No Value.

COC = Contaminant of Concern

RBSL = Risk-Based Screening Level

**TABLE A-11. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR A
HYPOTHETICAL RESIDENT AT IS-4**

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (μ g/L)	RME EXPOSURE POINT CONCENTRATION (μ g/L)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Carbon tetrachloride ^(b)	1.9	4.5	2.8E-05	1.2E-04	7E-04	4E-02	2E-01
bis(2-Ethylhexyl) phthalate	7.6	10	1.1E-04	2.8E-04	2E-02	6E-03	1E-02
Ethylbenzene	39	200	5.7E-04	5.5E-03	1E-01	6E-03	5E-02
Toluene	21	27	3.2E-04	1.0E-06	2E-01	2E-03	5E-06
Arsenic	3.7	4.9	5.7E-05	1.3E-04	3E-04	2E-01	4E-01
Cadmium	3.0	16	4.6E-05	4.4E-04	5E-04	9E-02	9E-01
Chromium ^(c)	7.7	14	1.2E-04	4.0E-04	5E-03	2E-02	8E-02
Manganese	830	3,900	1.3E-02	1.1E-01	5E-03	3E+00	2E+01
HAZARD INDEX						3E+00	2E+01

- (a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals are not presented due to lack of toxicity criteria: benzene, lead, 2-methyl naphthalene, and xylenes.
- (b) Carbon tetrachloride was only detected in deep aquifer monitoring wells. Therefore, the average and RME exposure point concentrations were based on deep aquifer samples.
- (c) The maximum detected value for chromium was 41 μ g/L which was detected once in the deep aquifer. The risk calculation, however, is based on the shallow aquifer detected concentrations because of the frequency of detection was higher.

TABLE A-12. CANCER RISK ASSOCIATED THE INGESTION OF GROUND WATER FOR A HYPOTHETICAL RESIDENT AT IS-4

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (μ g/L)	RME EXPOSURE POINT CONCENTRATION (μ g/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	9.6	14	1.9E-05	1.7E-04	2.9E-02	5E-07	5E-06
Carbon tetrachloride ^(b)	1.9	4.5	3.6E-06	5.3E-05	1.3E-01	5E-07	7E-06
bis (2-Ethylhexyl) phthalate	7.6	10	1.5E-05	1.2E-04	1.4E-02	2E-07	2E-06
Arsenic	3.7	4.9	7.3E-06	5.7E-05	1.75E+00	1E-05	1E-04
TOTAL RISK						1E-05	1E-04

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: cadmium, chromium, ethylbenzene, lead, manganese, 2-methyl naphthalene and xylenes.

(b) Carbon tetrachloride was only detected in deep aquifer monitoring wells. Therefore, the average and RME exposure point concentrations were based on deep aquifer samples.

TABLE A-13. NONCANCER HAZARD ASSOCIATED WITH THE INHALATION OF VOLATILES DURING SHOWERING BY A HYPOTHETICAL RESIDENT AT IS-4

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION REFERENCE DOSE (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Ethylbenzene	2.14E-01	1.1E+00	1.7E-04	2.0E-03	3E-01	1E-03	6E-03
HAZARD INDEX						1E-03	6E-03

- (a) Dose for the inhalation of volatiles from showering pathway have been calculated for volatile chemicals of concern with inhalation reference doses. The following chemical is not presented due to lack of inhalation toxicity criteria: benzene, carbon tetrachloride, 2-methylnaphthalene, toluene, and xylenes.
- (b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) model. These values represent the average air concentration for total shower exposure.

TABLE A-14. CANCER RISK ASSOCIATED WITH THE INHALATION OF VOLATILES DURING SHOWERING FOR A HYPOTHETICAL RESIDENT AT IS-4

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	5.8E-02	8.6E-02	5.8E-06	5.9E-05	2.9E-02	2E-07	2E-06
Carbon tetrachloride	9.1E-03	2.2E-02	9.1E-07	1.5E-05	1.3E-01	1E-07	2E-06
TOTAL RISK						3E-07	4E-06

(a) Dose for the inhalation of volatiles from showering pathway have been calculated for volatile chemicals of concern with inhalation slope factors. The following chemical is not presented due to lack of inhalation toxicity criteria: ethylbenzene, bis(2-ethylhexyl)phthalate, 2-methylnaphthalene, toluene and xylenes.

(b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) model. These values represent the average air concentration for total shower exposure.

TABLE A-15. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT IS-4

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION ($\mu\text{g/L}$)	RME EXPOSURE POINT CONCENTRATION ($\mu\text{g/L}$)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Carbon tetrachloride ^(b)	1.9	4.5	1.8E-05	4.4E-05	7E-04	3E-02	6E-02
bis(2-Ethylhexyl) phthalate	7.6	10	7.4E-05	1.0E-04	2E-02	4E-03	5E-03
Ethylbenzene	39	200	3.8E-04	2.0E-03	1E-01	4E-03	2E-02
Toluene	21	27	2.0E-04	2.6E-04	2E-01	1E-03	1E-03
Arsenic	3.7	4.9	3.7E-05	4.8E-05	3E-04	1E-01	2E-01
Cadmium	3.0	16	3.0E-05	1.6E-04	5E-04	6E-02	3E-01
Chromium ^(c)	7.7	14	7.6E-05	1.4E-04	5E-03	2E-02	3E-02
Manganese	830	3,900	8.1E-03	3.8E-02	5E-03	2E+00	8E+00
HAZARD INDEX						2E+00	8E+00

- (a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals are not presented due to lack of toxicity criteria: benzene, lead, 2-methyl naphthalene, and xylenes.
- (b) Carbon tetrachloride was only detected in deep aquifer monitoring wells. Therefore, the average and RME exposure point concentrations were based on deep aquifer samples.
- (c) The maximum detected value for chromium was 41 $\mu\text{g/L}$ which was detected once in the deep aquifer. The exposure point concentration, however, is based on the samples collected from the shallow aquifer because the frequency of detection was higher for chromium.

TABLE A-16. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR AIR FORCE PERSONNEL/CONTRACTORS AT IS-4

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	9.6	14	1.3E-05	4.9E-05	2.9E-02	4E-07	1E-06
Carbon tetrachloride ^(b)	1.9	4.5	2.6E-06	1.6E-05	1.3E-01	3E-07	2E-06
bis (2-Ethylhexyl) phthalate	7.6	10	1.1E-05	3.4E-05	1.4E-02	1E-07	5E-07
Arsenic	3.7	4.9	5.2E-06	1.7E-05	1.75E+00	9E-06	3E-05
TOTAL RISK						1E-05	3E-05

- (a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: cadmium, chromium, ethylbenzene, lead, manganese, 2-methyl naphthalene and xylenes.
- (b) Carbon tetrachloride was only detected in deep aquifer monitoring wells. Therefore, the average and RME exposure point concentrations were based on deep aquifer samples.

TABLE A-17. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT IS-4^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Manganese	830	3,900	9.0E-04	1.4E-02	5E-03	2E-01	3E+00
Total petroleum hydrocarbons (as JP-4)	1,200	6,000	1.0E-03	2.2E-02	8E-02	2E-04	3E-01
HAZARD INDEX						2E-01	3E+00

(a) Surface and subsurface soil were combined to evaluate this scenario where data were available and useable.

(b) Soil ingestion doses were calculated for those chemicals of concern with oral reference doses. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; lead; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene

TABLE A-18. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT IS-4^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Manganese	830	3,900	4.1E-04	1.9E-03	5E-03	8E-02	4E-01
Total petroleum hydrocarbons (as JP-4)	1,200	6,000	1.0E-03	3.0E-03	8E-02	7E-03	4E-02
HAZARD INDEX						9E-02	4E-01

(a) Surface and subsurface soil were combined to evaluate this scenario where data were available and useable.

(b) Soil ingestion doses were calculated for those chemicals of concern with oral reference doses. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; lead; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-19. NONCANCER HAZARD ASSOCIATED WITH THE INHALATION OF SOIL BY A HYPOTHETICAL RESIDENT AT IS-4^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Manganese	830	3,900	3.8E-05	2.3E-07	1.43E-05	3E-03	2E-02
HAZARD INDEX						3E-03	2E-02

- (a) Surface and subsurface soil were combined to evaluate this scenario where data were available and useable.
- (b) Inhalation of soil doses were calculated for those chemicals of concern with inhalation reference doses. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; lead; n-propylbenzene; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-20. NONCANCER HAZARD ASSOCIATED WITH FOR THE INHALATION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT IS-4^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Manganese	830	3,900	3.5E-08	1.6E-07	1.43E-05	2E-03	1E-02
HAZARD INDEX						2E-03	1E-02

(a) Surface and subsurface soil were combined to evaluate this scenario were data were available and useable.

(b) Inhalation of soil doses were calculated for those chemicals of concern with inhalation reference doses. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; lead; n-propylbenzene; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-21. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SURFACE WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT IS-4^(a)

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Arsenic	3.6	5.4	3.5E-07	1.6E-05	3E-04	1E-03	5E-02
Chromium	5.0	9.6	4.9E-07	2.8E-05	5E-03	1E-04	6E-03
Manganese	265.8	850	2.6E-05	2.5E-03	5E-03	5E-03	5E-01
HAZARD INDEX						6E-03	6E-01

(a) Surface water ingestion doses have been calculated for those chemicals of concern with oral reference doses, therefore, although lead is a chemical of concern, the noncancer hazard for this metal cannot be quantified because there is no oral reference dose for lead.

TABLE A-22. CANCER RISK ASSOCIATED THE INGESTION OF SURFACE WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT IS-4

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Arsenic	3.6	5.4	5E-08	6.4E-06	1.75E+00	9E-08	1E-05
TOTAL RISK						9E-08	1E-05

^(a) Surface water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: chromium, lead, and manganese.

**TABLE A-23. SUMMARY OF NONCANCER HAZARD AT FAIRCHILD AIR FORCE
BASE SITE IS-4**

RECEPTOR/PATHWAY	AVERAGE HAZARD INDEX	RME HAZARD INDEX
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	2E-03	1E-02
Ingestion of Soil	9E-02	4E-01
Ingestion of Ground Water	2E+00	8E+00
Ingestion of Surface Water	6E-03	6E-01
CUMULATIVE HAZARD INDEX	2E+00	8E+00
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	3E-03	2E-02
Ingestion of Soil	4E-01	3E+00
Ingestion of Ground Water	3E+00	2E+01
Inhalation of Volatiles During Showering	1E-03	6E-03
CUMULATIVE HAZARD INDEX	3E+00	2E+01

**TABLE A-24. CUMULATIVE CANCER RISK AT FAIRCHILD AIR FORCE
BASE SITE IS-4**

RECEPTOR/PATHWAY	AVERAGE RISK	RME RISK
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	1E-05	3E-05
Ingestion of Surface Water	9E-08	1E-05
CUMULATIVE CANCER RISK	1E-05	4E-05
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	1E-05	1E-04
Inhalation of Volatiles During Showering	3E-07	4E-06
CUMULATIVE CANCER RISK	1E-05	1E-04

TABLE A-25. CONCENTRATIONS OF THE CONTAMINANTS OF CONCERN AT SITE PS-1

MEDIUM	COC	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Soil	TPH-D	9,185 mg/kg	435.2 mg/kg
Ground water	TPH-D	7,000 μ g/L	1,080 μ g/L
	Benzene	950 μ g/L	121 μ g/L

**TABLE A-26. RESULTS OF RI NON-METALS SOIL SAMPLE ANALYSES
AT PS-1**

ANALYTE	NUMBER OF DETECTIONS/ANALYSES	LOCATIONS*	MAXIMUM DETECTION (mg/kg)
TPH-D (CA 8015)	16/37	B-12, 13, 15, MW-208	9185J
VOC (SW8260)			
n-Butylbenzene	6/53	B-13, 15, 208R	2.20
sec-Butylbenzene	6/53	B-12R , 15, 208R	1.50
t-Butylbenzene	2/53	B-13, 15	7.42R
Benzene	1/53	B-12R	0.73
Toluene	5/53	B-12, 12R , 14, 15, 40	0.14
Chlorobenzene	1/53	B-12R	0.07
p-Cymene (p-Isopropyltoluene)	13/53	B-12, 12R , 13, 15, 208R, MW-208	2.80
1,4-Dichlorobenzene	2/53	B-13, 14	0.02R
Ethylbenzene	10/53	B-12, 12R , 15, 208R	4.80
Trichlorofluoromethane	1/53	B-12	0.01R
Isopropylbenzene (Cumene)	7/53	B-12, 12R , 15, 208R	1.4
Methylene Chloride	9/53	B-12, 12R , 40R, 208R, MW-208	0.62
Naphthalene	12/53	B-12, 12R , 13, 15, 208R	5.20
n-Propylbenzene	9/53	B-12R, 15, 208R, MW-208	2.70
1,2,4-Trimethylbenzene	17/53	B-12, 12R , 13, 15, 40, 208R, MW-208	43.0
1,3,5-Trimethylbenzene	20/53	B-12, 12R , 13, 15, 40, 208R, MW-208	17.0
m,p-Xylene	17/53	B-12, 12R , 13, 15, 40, 208R, MWB-208	24.0
o-Xylene	15/53	B-12, 12R , 13, 15, 40, 208R, MW-208	8.80
1-Methylethylbenzene	1/53	B-12R	0.83
SVOC (SW8270)			
2-Methylnaphthalene	4/25	B-12, 12R , 13, 15	6.34
Naphthalene	3/25	B-12, 12R , 15	4.53

BOLD = Location of maximum detection.

J = Data are estimates.

R = When placed next to a numerical detection, this means data are rejected.

TABLE A-27. RESULTS OF RI NON-METALS GROUND WATER SAMPLE ANALYSES AT PS-1

ANALYTE	NUMBER OF DETECTIONS/ANALYSES	LOCATIONS ^(a)	MAXIMUM DETECTION (µg/L)
TPH-D (CA 8015)	7/13 ^(b)	MW-207, 208	7000J
VOC (SW8260)			
sec-Butylbenzene	2/13	MW-196, MW-208	12.0
Benzene	5/13	MW-196, MW-208	950
Toluene	1/13	MW-208	4.0
p-Cymene (p-Isopropyltoluene)	2/13	MW-208	35.0
Ethylbenzene	5/13	MW-196, MW-208	590
Hexachlorobutadiene	1/13	MW-208	24.0
Isopropylbenzene (Cumene)	5/13	MW-196, MW-208	63.0
Naphthalene	5/13	MW-208	170
n-Propylbenzene	4/13	MW-208	78.0
1,2,3-Trichlorobenzene	1/13	MW-208	130
1,2,4-Trichlorobenzene	1/13	MW-208	50.0
1,2,4-Trimethylbenzene	5/13	MW-208	550
1,3,5-Trimethylbenzene	2/13	MW-208	380
m,p-Xylene	5/13	MW-208	1700
o-Xylene	5/13	MW-208	120
1-Methylethylbenzene	4/13	MW-208	52
SVOC (SW8270)			
2,4-Dimethylphenol	1/7	MW-208	38.0
2-Methylnaphthalene	3/7	MW-208	51.0
Naphthalene	3/7	MW-208	110

(a) **BOLD** = Location of maximum detection.

(b) Includes one detection noted by the laboratory as "Unknown Extractable Hydrocarbon."

J = Data are estimates.

R = Data are rejected.

TABLE A-28. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN SOIL AT PS-1

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	PS-1 HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS						
Aluminum	10,000	---	---	---	14,000	NO
Arsenic	15	1.4	0.04	8.2	19	NO
Barium	123	5,600	---	1,900	200	NO
Beryllium	0.66	0.23	0.01	140	0.25	YES
Cadmium	0.56	40	---	27	0.28	NO
Calcium	8,700	---	---	---	8,400	NO
Chromium (VI)	18	400	---	140	18	NO
Cobalt	15	---	---	---	18	NO
Copper	18	3,000	---	1,000	16	NO
Iron	27,000	---	---	---	29,000	NO
Lead	46	---	---	---	18	NO
Magnesium	6,900	---	---	---	6,000	NO
Manganese	840	400	---	3,800	730	YES
Nickel	18	1,600	---	550	17	NO
Potassium	2,300	---	---	---	2,600	NO
Silver	6.8	240	---	140	0.5	NO
Sodium	480	---	---	---	590	NO
Vanadium	54	560	---	190	54	NO
Zinc	53	24,000	---	8,200	52	NO
ORGANICS						
Benzene	0.73	1.5	2.2	---	---	NO
sec-Butylbenzene	1.5	---	---	---	---	YES
n-Butylbenzene	2.20	---	---	---	---	YES
Chlorobenzene	0.07	1,600	---	550	---	NO

**TABLE A-28. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOIL AT PS-1 (Continued)**

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON- CARCINOGENS ^(e)	PS-1 HNBC ^(f)	POTENTIAL COC ^(g)
p-Cymene	2.8	---	---	---	---	YES
Diesel (total petroleum hydrocarbons)	9,185	---	---	2,200 ^(h)	---	YES
Ethylbenzene	4.8	8,000	---	2,700	---	NO
Isopropylbenzene	1.4	---	---	1,100	---	NO
Methylene chloride	0.62	130	8.5	1,600	---	NO
2-Methylnaphthalene	6.3	---	---	---	---	YES
Naphthalene	5.2	320	---	1,100	---	NO
n-Propylbenzene	2.7	---	---	---	---	YES
Toluene	0.14	16,000	---	5,500	---	NO
1,2,4-Trimethylbenzene	43	---	---	---	---	YES
1,3,5-Trimethylbenzene	8	---	---	---	---	YES
Total Xylenes (m,p, and o)	33	160,000	---	55,000	---	NO

- (a) All values rounded to two significant digits
- (b) The screening was conservatively performed on the maximum concentration detected over all depths analyzed. Contaminants detected in surface soil will be evaluated in the exposure assessment.
- (c) The Model Toxics Control Act (MTCA) cleanup regulation (173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (EPA 1991 Ibid), the soil RBSL is based on a 1×10^{-7} risk.
- (e) Based on EPA Region 10 guidance (EPA 1991 Ibid), the soil RBSL is based on a 0.1 hazard quotient.
- (f) The PS-1 High Normal Background Concentrations (HNBC) were calculated and referenced in Appendix J. There is no background data for organics. See text.
- (g) Potential contaminants of concern include metals that exceed (or do not have) the lowest criterion presented and exceed the HNBC as well as organic compounds that exceed (or do not have) the lowest criterion presented. Contaminants without an RBSL lack toxicity criterion. Based on EPA Region 10 guidance (EPA 1991 Ibid), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement. Based on EPA Region 10 guidance (EPA 1991b), if chromium, cadmium, elemental mercury, or carcinogenic forms of nickel are presented as contaminants of concern in soil, they should not be eliminated based on soil ingestion screening criterion. However, if concentrations are less than background, they will not be evaluated further.
- (h) The noncarcinogenic RBSL is based on a provisional oral reference dose for JP-4 which, for the purposes of this risk assessment, will be assumed to be similar to diesel.

--- = No Value

COC = Contaminants of Concern

RBSL = Risk-Based Screening Level

TABLE A-29. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN GROUND WATER AT PS-1

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	PS-1 HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS							
Aluminum	18,000	---	---	---	---	16,000	NO
Arsenic	70	50	0.05	0.05	1.1	2	YES
Barium	430	2,000	1,100	---	260	2,700	NO
Beryllium	3.0	4	0.02	0.02	18	6	NO
Calcium	170,000	---	---	---	---	---	NO
Copper	13	---	590	---	---	50	NO
Cobalt	22	1,300	---	---	140	30	NO
Iron	29,000	---	---	---	---	35,000	NO
Lead	6.5	15 ^(h)	---	---	---	20	NO
Magnesium	51,000	---	---	---	---	---	NO
Manganese	7,000	---	80	---	18	1,500	YES
Molybdenum	45	---	80	---	---	610	NO
Nickel	84	100	320	---	73	350	NO
Potassium	4,100	---	---	---	---	---	NO
Selenium	39	---	---	---	---	4	YES
Silver	15	50	48	---	18	5	NO
Sodium	54,000	---	---	---	---	---	NO
Vanadium	53	---	110	---	26	330	NO
Zinc	64	---	4,800	---	1,100	40	NO
ORGANICS							
Benzene	950	5	35	0.60	---	---	YES
sec-Butylbenzene	12	---	---	---	---	---	YES
p-Cymene	35	---	---	---	---	---	YES
Diesel (total petroleum hydrocarbons)	7.0	---	---	---	2,900	---	NO

TABLE A-29. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN GROUND WATER AT PS-1 (Continued)

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	PS-1 HNBC ^(f)	POTENTIAL COC ^(g)
2,4-Dimethylphenol	38	---	320	---	73	---	NO
Ethylbenzene	590	700	800	---	160	---	YES
Hexachlorobutadiene	24	---	---	1.1	7.3	---	YES ⁽ⁱ⁾
Isopropylbenzene	63	---	0.56	---	2.8	---	YES
2-Methylnaphthalene	51	---	---	---	---	---	YES
Naphthalene	170	---	32	---	150	---	YES
n-Propylbenzene	78	---	---	---	---	---	YES
Toluene	4	1,000	1,600	---	97	---	NO
1,2,4-Trichlorobenzene	50	70	80	---	2.0	---	YES
1,2,3-Trichlorobenzene	130	---	---	---	---	---	YES
1,2,4-Trimethylbenzene	550	---	---	---	---	---	YES
1,3,5-Trimethylbenzene	380	---	---	---	---	---	YES
Total Xylenes (m,p, and o)	1,735	10,000	16,000	---	80	---	YES

(a) All values rounded to two significant digits.

(b) Federal Maximum Contaminant Levels (MCL) for drinking water.

(c) The Model Toxics Control Act (MTCA) cleanup regulation (173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.

(d) Based on EPA Region 10 guidance (EPA 1991 Ibid), the ground water RBSL is based on a 1×10^{-6} risk. RBSLs for volatile contaminants with an inhalation slope factor were calculated based on ingestion and inhalation of volatiles from ground water.

(e) Based on EPA Region 10 guidance (EPA 1991 Ibid), the ground water RBSL for non-carcinogens is based on a 0.1 hazard quotient. RBSLs for volatile contaminants with inhalation reference doses were calculated based on ingestion and inhalation of volatiles from ground water.

(f) Site PS-1 High Normal Background Concentrations (HNBC) were calculated and referenced in Appendix J.

(g) Potential contaminants of concern include contaminants that exceed (or do not have) the lowest criterion presented and that exceed background. However, based on EPA Region 10 guidance (EPA 1991 Ibid), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.

(h) Action level: exceeded if the level of concentration in more than 10% of targeted tap samples is greater than the specified value (90th percentile).

(i) Chosen as a potential contaminants of concern; however, presence of this contaminant may be due to blank contamination.

(j) The noncarcinogenic RBSL is based on a provisional oral reference dose for JP-4 which, for the purposes of this risk assessment, will be assumed to be similar to diesel.

--- = No Value.

COC = Contaminants of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-30. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT PS-1^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Beryllium	0.270	0.3	2.9E-07	1.1E-06	5E-03	6E-05	2E-04
Manganese	400	450	4.3E-04	1.6E-03	5E-03	9E-02	3E-01
Total petroleum hydrocarbons (as JP-4)	440	770	4.7E-04	3.0E-03	8E-02	6E-03	3E-02
HAZARD INDEX						1E-01	3E-01

- (a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.
- (b) Soil ingestion doses were calculated for those chemicals of concern with oral reference doses. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; p-cymene; 2-methylnaphthalene; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-31. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT PS-1^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Beryllium	0.270	0.30	3.7E-08	4.7E-07	4.3E+00	2E-07	2E-06
TOTAL RISK						2E-07	2E-06

- (a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.
- (b) Soil ingestion doses were calculated for those chemicals of concern with oral cancer slope factors. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; p-cymene; manganese; 2-methylnaphthalene; n-propylbenzene; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-32. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-1^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Beryllium	0.270	0.3	1.3E-07	1.5E-07	5E-03	3E-05	3E-05
Manganese	400	450	2.0E-04	2.2E-04	5E-03	4E-02	4E-02
Total petroleum hydrocarbons (as JP-4)	440	770	2.2E-04	3.8E-04	8E-02	3E-03	5E-03
HAZARD INDEX						4E-02	4E-02

- (a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.
- (b) Soil ingestion doses were calculated for those chemicals of concern with oral reference doses. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; p-cymene; 2-methylnaphthalene; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-33. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/ CONTRACTORS AT PS-1^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-DAY)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-DAY)	ORAL SLOPE FACTOR (mg/kg-DAY) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Beryllium	0.270	0.30	1.9E-08	5.3E-08	4.3E+00	8E-08	2E-07
TOTAL RISK						8E-08	2E-07

(a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.

(b) Soil ingestion doses were calculated for those chemicals of concern with oral cancer slope factors. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; p-cymene; manganese; 2-methylnaphthalene; n-propylbenzene; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-34. NONCANCER HAZARD ASSOCIATED WITH THE INHALATION OF SOIL BY A HYPOTHETICAL RESIDENT AT PS-1^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-DAY)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-DAY)	INHALATION REFERENCE DOSE (RFD) (mg/kg-DAY)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Manganese	400	450	1.8E-08	2.7E-08	1.43E-05	1E-03	2E-03
HAZARD INDEX						1E-03	2E-03

- (a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.
- (b) Soil ingestion doses were calculated for those chemicals of concern with inhalation reference doses. The following chemicals were not presented due to lack of toxicity criteria: beryllium; sec-butylbenzene; n-butylbenzene; p-cymene; 2-methylnaphthalene; n-propylbenzene; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-35. CANCER RISK ASSOCIATED WITH THE INHALATION OF SOIL BY A HYPOTHETICAL RESIDENT AT PS-1^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Beryllium	0.270	0.30	1.6E-12	1.4E-10	8.4E+00	1E-11	1E-09
TOTAL RISK						1E-11	1E-09

- (a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.
- (b) Soil ingestion doses were calculated for those chemicals of concern with oral cancer slope factors. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; p-cymene; total petroleum hydrocarbons; manganese; 2-methylnaphthalene; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-36. NONCANCER HAZARD ASSOCIATED WITH THE INHALATION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-1^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Manganese	400	450	1.7E-08	1.9E-08	1.43E-05	1E-03	1E-03
HAZARD INDEX						1E-03	1E-03

(a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.

(b) Soil ingestion doses were calculated for those chemicals of concern with inhalation reference doses. The following chemicals were not presented due to lack of toxicity criteria: beryllium; sec-butylbenzene; n-butylbenzene; p-cymene; 2-methylnaphthalene; n-propylbenzene; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

**TABLE A-37. CANCER RISK ASSOCIATED WITH THE INHALATION OF SOIL BY AIR FORCE PERSONNEL/
CONTRACTORS AT PS-1^(a)**

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Beryllium	0.270	0.30	1.6E-12	4.5E-12	8.4E+00	1E-11	4E-11
TOTAL RISK						1E-11	4E-11

- (a) Surface and subsurface soil were combined to evaluate this scenario. Contaminant concentrations for volatile organics in surface soil were either rejected due to holding times or non-detected.
- (b) Soil ingestion doses were calculated for those chemicals of concern with oral cancer slope factors. The following chemicals were not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; p-cymene; total petroleum hydrocarbons; manganese; 2-methylnaphthalene; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-38. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER BY A HYPOTHETICAL RESIDENT AT PS-1

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Ethylbenzene	120	590	2.0E-03	1.6E-02	1E-01	2E-02	2E-01
Hexachlorobutadiene	4.5	24	6.8E-05	6.6E-04	2E-04	3E-01	3E-00
Isopropylbenzene	17	63	2.6E-04	1.7E-03	4E-02	6E-03	4E-02
1,2,4-Trichlorobenzene	11	35	1.6E-04	1.0E-03	1E-02	2E-02	1E-01
Xylenes (m,p-mixed)	560	1,800	8.5E-03	4.9E-02	2E+00	4E-03	2E-02
Arsenic	25	70	3.8E-04	1.9E-03	3E-04	1E+00	6E+00
Manganese	2,000	7,000	3.0E-02	1.9E-01	5E-03	6E+00	4E+01
Selenium	6.1	11	9.2E-05	2.6E-05	5E-03	5E-03	2E-01
HAZARD INDEX						7E+00	5E+01

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals are not presented due to lack of toxicity criteria: benzene, sec-butylbenzene, n-propylbenzene, p-cymene, naphthalene, 2-methylnaphthalene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, and 1,2,3-trichlorobenzene.

TABLE A-39. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR A HYPOTHETICAL RESIDENT AT PS-1

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	120	950	2.3E-04	1.1E-02	2.9E-02	7E-06	3E-04
Hexachlorobutadiene	4.5	24	8.7E-06	2.8E-04	7.8E-02	7E-07	2E-05
Arsenic	25	70	4.8E-05	8.2E-04	1.75E+00	8E-05	1E-03
TOTAL RISK						9E-05	2E-03

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: sec-butylbenzene, n-propylbenzene, p-cymene, naphthalene, 2-methylnaphthalene, ethylbenzene, isopropylbenzene, 1,2,4-trichlorobenzene, xylenes, manganese, selenium, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, and 1,2,3-trichlorobenzene.

TABLE A-40. NONCANCER HAZARD ASSOCIATED WITH THE INHALATION OF VOLATILES DURING SHOWERING BY A HYPOTHETICAL RESIDENT AT PS-1

CHEMICAL ^(A)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) (b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) (b)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION REFERENCE DOSE (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Ethylbenzene	8.8E-01	3.3E+00	6.9E-04	5.6E-03	3E-01	2E-03	2E-02
Isopropylbenzene	8.8E-02	3.4E-01	6.9E-05	5.7E-04	3E-03	2E-02	2E-01
1,2,4-Trichlorobenzene	6.2E-01	2.0E-01	4.9E-04	3.4E-04	3E-03	2E-01	1E-01
HAZARD INDEX						2E-01	3E-01

(a) Dose for the inhalation of volatiles from showering pathway have been calculated for volatile chemicals of concern with inhalation reference doses. The following chemical is not presented due to lack of inhalation toxicity criteria: benzene, sec-butylbenzene, n-butylbenzene, hexachlorobutadiene, n-propylbenzene, p-cymene, naphthalene, 2-methylnaphthalene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 1,2,3-trichlorobenzene, and xylenes.

(b) Average and RME Exposure Point Concentrations were derived using the Foster and Chróstowski (1987) model. These values represent the average air concentration for total shower exposure.

TABLE A-41. CANCER RISK ASSOCIATED WITH THE INHALATION OF VOLATILES DURING SHOWERING FOR A HYPOTHETICAL RESIDENT AT PS-1

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	9.9E-01	5.8E+00	1.0E-04	4.3E-03	2.9E-02	3E-06	1E-04
Hexachlorobutadiene	1.8E-02	9.3E-02	1.8E-06	6.8E-05	7.8E-02	1E-07	5E-06
TOTAL RISK						3E-06	1E-04

- (a) Dose for the inhalation of volatiles from showering pathway have been calculated for volatile chemicals of concern with inhalation slope factors. The following chemical is not presented due to lack of inhalation toxicity criteria: sec-butylbenzene, ethylbenzene, isopropylbenzene, n-propylbenzene, p-cymene, naphthalene, 2-methylnaphthalene, 1,2,4-trichlorobenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, 1,2,3-trichlorobenzene, and xylenes.
- (b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) model. These values represent the average air concentration for total shower exposure.

**TABLE A-42. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER BY
AIR FORCE PERSONNEL/CONTRACTORS AT PS-1**

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (μ g/L)	RME EXPOSURE POINT CONCENTRATION (μ g/L)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Ethylbenzene	120	590	1.0E-03	5.8E-03	1E-01	1E-02	6E-02
Hexachlorobutadiene	4.5	24	4.4E-05	2.4E-04	2E-04	2E-01	1E+00
Isopropylbenzene	17	63	1.7E-04	6.2E-04	4E-02	4E-03	2E-02
1,2,4-Trichlorobenzene	11	35	1.1E-04	3.4E-04	1E-02	1E-02	3E-02
Xylenes (m,p-mixed)	560	1,800	5.5E-03	1.8E-02	2E+00	3E-03	9E-03
Arsenic	25	70	2.5E-04	6.9E-04	3E-04	8E-01	2E+00
Manganese	2,000	7,000	2.0E-02	6.9E-02	5E-03	4E+00	1E+01
Selenium	6.1	11	1.1E-04	3.8E-04	5E-03	2E-02	8E-02
HAZARD INDEX						5E+00	1E+01

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals are not presented due to lack of toxicity criteria: benzene, sec-butylbenzene, n-propylbenzene, p-cymene, naphthalene, 2-methylnaphthalene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, and 1,2,3-trichlorobenzene.

TABLE A-43. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-1

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	120	950	1.6E-04	3.3E-03	2.9E-02	5E-06	1E-04
Hexachlorobutadiene	4.5	24	6.3E-06	8.4E-05	7.8E-02	5E-07	7E-06
Arsenic	25	70	3.5E-05	2.4E-04	1.75E+00	6E-05	4E-04
TOTAL RISK						6E-05	1E-03

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: sec-butylbenzene, n-propylbenzene, p-cymene, naphthalene, 2-methylnaphthalene, ethylbenzene, isopropylbenzene, 1,2,4-trichlorobenzene, xylenes, manganese, selenium, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, and 1,2,3-trichlorobenzene.

**TABLE A-44. SUMMARY OF NONCANCER HAZARD AT FAIRCHILD AIR FORCE
BASE SITE PS-1**

RECEPTOR/PATHWAY	AVERAGE HI	RME HI
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	1E-03	1E-03
Ingestion of Soil	4E-02	4E-02
Ingestion of Ground Water	5E+00	2E+01
CUMULATIVE HAZARD INDEX	5E+00	2E+01
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	1E-03	2E-03
Ingestion of Soil	1E-01	3E-01
Ingestion of Ground Water	7E+00	5E+01
Inhalation of Volatiles During Showering	2E-01	3E-01
CUMULATIVE HAZARD INDEX	7E+00	5E+01

**TABLE A-45. CUMULATIVE CANCER RISK AT FAIRCHILD AIR FORCE
BASE SITE PS-1**

RECEPTOR/PATHWAY	AVERAGE RISK	RME RISK
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	1E-11	4E-11
Ingestion of Soil	8E-08	2E-07
Ingestion of Ground Water	6E-05	1E-03
CUMULATIVE CANCER RISK	6E-05	1E-03
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	1E-11	1E-09
Ingestion of Soil	2E-07	2E-06
Ingestion of Ground Water	9E-05	2E-03
Inhalation of Volatiles During Showering	3E-06	1E-04
CUMULATIVE CANCER RISK	9E-05	2E-03

TABLE A-46. CONCENTRATIONS OF CONTAMINANTS OF CONCERN AT SITE PS-5

MEDIUM	COC	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Soil	TPH-D	6,700 mg/kg	346 mg/kg
Ground water	TPH-D	1,800 µg/L	446.1 µg/L

**TABLE A-47. SUMMARY OF RESULTS OF NON-METALS SOIL ANALYSES
SAMPLES AT PS-5**

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS	MAXIMUM DETECTION (mg/kg)
TPH-D (CA8015)	1/14	B-47	342J
VOC (SW8260)			
Benzene	1/15	B-48	0.05323R
Toluene	1/15	B-48	0.04417R
1,1-Dichloroethane	1/15	B-48	0.06569R
1,2-Dichloroethane	1/15	B-48	0.05210R
Trichloroethylene	1/15	B-48	0.04530R
m,p-Xylene(s)	1/15	B-48	0.06455R
o-Xylene	1/15	B-48	0.03398R
Chlorobenzene	1/15	B-48	0.03284R

**TABLE A-48. SUMMARY OF RESULTS OF NON-METALS GROUND WATER
ANALYSES SAMPLES AT PS-5**

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS*	MAXIMUM DETECTION (µg/L)
TPH-D (CA8015)	9/18	MW-41, 42, 46, 213	1800
VOC (SW8260)			
sec-Butylbenzene	6/18	MW-42, 213	4.0
p-Cymene	2/18	MW-42	1.0R
Isopropylbenzene	3/18	MW-42	1.0
1,2,4-Trimethylbenzene	2/18	MW-42	1.0
1,3,5-Trimethylbenzene	3/18	MW-42	2.0R

* BOLD = Location of maximum detection.
R = Data are rejected.

TABLE A-49. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN SOIL AT PS-5

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)				
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	POTENTIAL COC ^(f)
ORGANICS					
Ethylbenzene	9.9	8,000	---	2,600	NO
Toluene	0.012	16,000	---	5,000	NO
Heating oil No. 2 (total petroleum hydrocarbons)	6,700	---	---	---	YES
Xylenes	78	160,000	---	54,000	NO

(a) All values rounded to two significant digits.

(b) The screening was conservatively performed on the maximum concentration detected over all depths.

(c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.

(d) Based on EPA Region 10 guidance (1991b), the soil RBSL for carcinogens is based on a 1×10^{-7} risk.

(e) Based on EPA Region 10 guidance (1991b), the soil RBSL for noncarcinogens is based on a 0.1 hazard quotient.

(f) Potential contaminants of concern (PCOC) include contaminants that exceed the lowest screening level and exceed background, or do not have toxicity values with which to calculate a screening level. Based on EPA Region 10 guidance (EPA 1991 Ibid), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.

--- = No Value.

PCOC = Potential Contaminant of Concern

COC = Contaminant of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-50. RISK-BASED SCREENING LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN GROUND WATER AT PS-5

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) (a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS							
Aluminum	40,000	---	---	---	---	16,000	NO
Arsenic	57	50	0.05	0.05	1.1	2	YES
Barium	590	2,000	1,100	---	260	2,700	NO
Beryllium	5.5	4	0.02	0.02	18	6	NO
Cadmium	11	5	8	---	1.8	---	YES
Calcium	120,000	---	---	---	---	---	NO
Chromium ^(j)	45	100	80	---	18	30	YES
Cobalt	41	---	---	---	---	50	NO
Copper	110	1,300	590	---	140	30	NO
Iron	79,000	---	---	---	---	35,000	NO
Lead	40	15 ^(h)	---	---	---	20	YES
Magnesium	42,000	---	---	---	---	---	NO
Manganese	4,200	---	80	---	18	1,500	YES
Nickel	57	100	320	---	73	350	NO
Potassium	12,000	---	---	---	---	---	NO
Sodium	21,000	---	---	---	---	---	NO
Vanadium	160	---	110	---	26	330	NO
Zinc	230	---	4,800	---	1,100	40	NO

TABLE A-50. RISK-BASED SCREENING LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN GROUND WATER AT PS-5 (Continued)

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) (a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
ORGANICS							
Benzene	1.0	5	34	0.6	---	---	YES
sec-Butylbenzene	4.0	---	---	---	---	---	YES
Ethylbenzene	14	700	800	---	160	---	NO
Isopropylbenzene	1.0	---	---	---	2.8	---	NO
Toluene	3.0	1,000	1,600	---	97	---	NO
Diesel (total petroleum hydrocarbons)	1,800	---	---	---	---	---	YES
1,3,5-Trimethylbenzene	1.0	---	---	---	---	---	YES
Total Xylenes	154	10,000	16,000	---	80	---	YES

- (a) All values are rounded to two significant digits.
- (b) Federal Maximum Contaminant Levels (MCL) for drinking water.
- (c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (1991b), the ground water RBSL for carcinogens is based on a 1×10^{-6} risk. RBSLs for volatile chemicals with an inhalation slope factor were calculated based on ingestion and inhalation of volatiles from ground water.
- (e) Based on EPA Region 10 guidance (1991b), the ground water RBSL for noncarcinogens is based on a 0.1 hazard quotient. RBSLs for volatile chemicals with inhalation reference doses were calculated based on ingestion and inhalation of volatiles from ground water.
- (f) High Normal Background Concentrations (HNBC) were calculated and referenced in SAIC (1991).
- (g) Potential chemicals of concern (PCOC) include chemicals that exceed the lowest screening and exceed the background, or do not have toxicity values with which to calculate a screening level. However, based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.
- (h) Action level: exceeded if the level of concentration in more than 10% of targeted tap samples is greater than the specific value (90th percentile).
- (i) Chromium was assumed to be hexavalent to maintain a conservative risk assessment approach.

--- = No Value.

PCOC = Potential Contaminant of Concern

COC = Contaminant of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-51. CANCER RISK ASSOCIATED WITH INGESTION OF GROUND WATER BY A HYPOTHETICAL RESIDENTIAL AT PS-5

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	LIFE CARCINOGENIC RISK
Benzene	0.54	1.0	9.7E-07	1.2E-05	2.9E-03	3E-08	3E-07
Arsenic	26	57	5.0E-05	6.7E-04	1.75E+00	9E-05	1E-03
TOTAL RISK						9E-05	1E-03

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of oral toxicity criteria: cadmium, chromium, manganese, sec-butylbenzene, 1,3,5-trimethylbenzene and xylene.

TABLE A-52. CANCER RISK ASSOCIATED WITH INHALATION OF VOLATILES DURING SHOWERING BY A HYPOTHETICAL RESIDENTIAL AT PS-5

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) (b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) (b)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	3.3E-03	6.1E-03	3.3E-07	4.5E-06	2.9E-02	1E-08	1E-07
TOTAL RISK						1E-08	1E-07

(a) Dose for the inhalation of volatiles from showering pathway have been calculated for chemicals of concern with inhalation toxicity criteria. The following chemical is not presented due to lack of inhalation toxicity criteria: sec-butylbenzene, 1,3,5-trimethylbenzene, and xylenes.

(b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) model. These values represent the average air concentration for total shower exposure

TABLE A-53. NONCANCER HAZARD ASSOCIATED WITH INHALATION OF VOLATILES DURING SHOWERING BY A HYPOTHETICAL RESIDENT AT PS-5

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION REFERENCE DOSE (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Isopropylbenzene	2.9E-03	5.3E-03	2.3E-06	9.1E-06	3E-03	8E-04	3E-03
HAZARD INDEX						8E-04	3E-03

- (a) Dose for the inhalation of volatiles from showering pathway have been calculated for chemicals of concern with inhalation toxicity criteria. The following chemical is not presented due to lack of inhalation toxicity criteria: sec-butylbenzene, 1,3,5-trimethylbenzene, and xylenes.
- (b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) model. These values represent the average air concentration for total shower exposure (see Appendix X).

TABLE A-54. NONCANCER HAZARD ASSOCIATED WITH INGESTION OF GROUND WATER BY A HYPOTHETICAL RESIDENT AT PS-5

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Xylenes (total)	13	150	2.0E-04	4.1E-03	2E+00	5E-06	2E-03
Arsenic	26	57	3.9E-04	1.6E-03	3E-04	1E+00	5E+00
Cadmium	4.2	11	6.3E-05	3.0E-04	5E-04	1E-01	6E-01
Chromium (VI) ^(b)	13	45	2.0E-04	1.2E-03	5E-03	4E-02	2E-01
Manganese	1,300	4,200	2.0E-02	1.2E-01	5E-03	4E+00	2E+01
HAZARD INDEX						5E+00	3E+01

- (a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals are not presented due to lack of oral toxicity criteria: benzene, sec-butylbenzene and 1,3,5-trimethylbenzene.
- (b) Chromium was assumed to be hexavalent to maintain a conservative risk assessment approach.

**TABLE A-55. CANCER RISK ASSOCIATED WITH INGESTION OF GROUND WATER BY AIR FORCE
PERSONNEL/CONTRACTORS AT PS-5**

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (μ g/L)	RME EXPOSURE POINT CONCENTRATION (μ g/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Benzene	0.54	1.0	7.5E-07	3.5E-06	2.9E-03	2E-09	1E-08
Arsenic	26	57	3.6E-05	2.0E-04	1.75E+00	6E-05	3E-04
TOTAL RISK						6E-05	3E-04

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of oral toxicity criteria: cadmium, chromium, manganese, sec-butylbenzene, 1,3,5-trimethylbenzene and xylene.

TABLE A-56. NONCANCER HAZARD ASSOCIATED WITH INGESTION OF GROUND WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-5

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Xylenes (total)	13	150	1.3E-04	1.5E-03	2E+00	6E-05	7E-04
Arsenic	26	57	2.5E-04	5.6E-04	3E-04	8E-01	2E+00
Cadmium	4.2	11	4.1E-05	1.1E-04	5E-04	8E-02	2E-01
Chromium (VI)	13	45	1.3E-04	4.4E-04	5E-03	2E-02	9E-02
Manganese	1,300	4,200	1.3E-02	4.1E-02	5E-03	2E+00	8E+00
HAZARD INDEX						4E+00	1E+01

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals are not presented due to lack of oral toxicity criteria: benzene, sec-butylbenzene and 1,3,5-trimethylbenzene.

(b) Chromium was assumed to be hexavalent to maintain a conservative risk assessment approach.

TABLE A-57. SUMMARY OF NONCANCER HAZARD AT FAIRCHILD AIR FORCE BASE SITE PS-5

RECEPTOR/PATHWAY	AVERAGE HI	RME HI
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	4E+00	1E+01
CUMULATIVE HAZARD INDEX	4E+00	1E+01
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	5E+00	3E+01
Inhalation of Volatiles During Showering	8E-04	3E-03
CUMULATIVE HAZARD INDEX	5E+00	3E+01

TABLE A-58. CUMULATIVE CANCER RISK AT FAIRCHILD AIR FORCE BASE SITE PS-5

RECEPTOR/PATHWAY	AVERAGE RISK	RME RISK
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	6E-05	3E-04
TOTAL RISK	6E-05	3E-04
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	9E-05	1E-03
Inhalation of Volatiles During Showering	1E-08	1E-07
TOTAL RISK	9E-05	1E-03

TABLE A-59. CONCENTRATIONS OF CONTAMINANTS OF CONCERN AT SITE PS-7

MEDIUM	COC	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Soil	TPH-D	8,330 mg/kg	894 mg/kg
Ground water	TPH-D	3,200 µg/L	658 µg/L

TABLE A-60. SUMMARY OF RESULTS OF RI NON-METAL ANALYSES FOR GROUND WATER SAMPLES AT PS-7

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS*	MAXIMUM DETECTION (µg/L)
TPH (E 418.1)	4/28	MW-72, 73, 206	3200
VOC (SW8260)			
Bromodichloromethane	5/28	MW-71	1.8
1,4-Dichlorobenzene	1/28	MW-71	1.00
Naphthalene	3/28	MW-73, 204, 206	12.0
1,2,3-Trichlorobenzene	1/28	MW-204	2.00
Chloroform	14/28	MW-71, 72, 73, 204, 205	7.5
1,2,4-Trimethylbenzene	2/28	MW-206	1.00
SVOC (SW8270)			
bis(2-ethylhexyl)Phthalate	5/28	MW-71, 72, 73, 205	22.0
Benzyl Alcohol	4/28	MW-71, 204, 205, 206	30.0
Dimethyl Phthalate	1/28	MW-72	34.0
2-Methylphenol	1/28	MW-206	21.0

* BOLD = Location of maximum detection.

TABLE A-61. SUMMARY OF RESULTS OF NON-METAL ANALYSES FOR REMOVAL ACTION* CONFIRMATORY SOIL SAMPLES AT PS-7

ANAYLTE	NUMBER OF DETECTIONS/ ANALYSES	MAXIMUM DETECTION (mg/kg)	SAMPLE NUMBER
TPH (SW3550/E418.1)	7/16	8326	PS7-43092-2C

* In February 1992, the Air Force removed and treated approximately 400 yd³ of petroleum contaminated soil from PS-7. Approximately 60 yd³ of contaminated soil remains beneath Building 1350 and an adjacent asphalt parking lot.

TABLE A-62. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN GROUND WATER AT PS-7

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS							
Aluminum	2,400	---	---	---	---	16,000	NO
Barium	93	2,000	1,100	---	260	2,700	NO
Calcium	73,000	---	---	---	---	---	NO
Iron	3,500	---	---	---	---	35,000	NO
Magnesium	23,000	---	---	---	---	---	NO
Manganese	230	---	80	---	18	1,500	NO
Potassium	3,200	---	---	---	---	---	NO
Sodium	27,000	---	---	---	---	---	NO
ORGANICS							
Benzyl alcohol	30	---	4,800	---	1,100	---	NO
Bromodichloromethane	1.0	---	0.71	0.6	73	---	YES
Chloroform	3.4	---	7.2	0.3	37	---	YES
1,4-Dichlorobenzene	1.0	75	1.8	3.5	200	---	NO
Dimethylphthalate	3.0	---	16,000	---	36,000	---	NO
2-Methylphenol	21	---	---	---	180	---	NO
Naphthalene	12	---	32	---	150	---	NO

^(a) All values rounded to two significant figures.

^(b) Federal Maximum Contaminant Levels (MCL) for drinking water.

^(c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.

^(d) Based on EPA Region 10 guidance (1991b), the ground water RBSL for carcinogens is based on a 1×10^{-6} risk. RBSL for volatile chemicals with an inhalation slope factor were calculated based on ingestion and inhalation of volatiles from ground water.

^(e) Based on EPA Region 10 guidance (1991b), the ground water RBSL for noncarcinogens is based on a 0.1 hazard quotient. RBSL for volatile chemicals with inhalation reference doses were calculated based on ingestion and inhalation of volatiles from ground water.

^(f) The High Normal Background Concentrations were calculated and referenced in SAIC (1991). There is no background data for organic chemicals.

^(g) Potential COC include chemicals that exceed (or do not have) the lowest criteria presented and that exceed background concentrations. However, based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.

Note: The two grab samples from the LFI were not included with the ground water samples collected during the RI.

--- = No Value.

COC = Contaminants of Concern.

RBSL = Risk-Based Screening Level

TABLE A-63. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN SOIL AT PS-7

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
ORGANICS						
No. 6 Fuel Oil (total petroleum hydrocarbons)	8,330	---	---	---	---	YES

- (a) All values rounded to two significant digits.
- (b) The screening was conservatively performed on the maximum concentration detected over all depths analyzed. Chemicals detected in surface soil will be evaluated in the exposure assessment.
- (c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (1991b), the soil RBSL for carcinogens is based on a 1×10^{-7} risk.
- (e) Based on EPA Region 10 guidance (1991b), the soil RBSL for noncarcinogens is based on a 0.1 hazard quotient.
- (f) The High Normal Background Concentrations (HNBC) were calculated and referenced in SAIC (1991). There is no background data for organic chemicals. See text.
- (g) Potential COC include metals that exceed (or do not have) the lowest criterion presented and exceed the HNBC as well as organic compounds that exceed (or do not have) the lowest criterion presented. Chemicals without an RBSL lack toxicity criteria. Based on Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement. Based on EPA Region 10 guidance (1991b), if chromium, cadmium, elemental mercury, or carcinogenic forms of nickel are present as contaminants of concern in soil, they should not be eliminated based on soil ingestion screening criteria. However, if concentrations are less than background, they will not be evaluated further.

--- = No Value.

COC = Contaminants of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-64. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER BY A HYPOTHETICAL RESIDENT AT PS-7

CHEMICAL	AVERAGE EXPOSURE POINT CONCENTRATION ($\mu\text{g/L}$)	RME EXPOSURE POINT CONCENTRATION ($\mu\text{g/L}$)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Bromodichloromethane	0.65	1.0	9.8E-06	1.2E-05	6E-02	8E-08	7E-07
Chloroform	2.1	3.4	3.1E-05	4.0E-05	6.1E-03	2E-08	2E-07
TOTAL RISK						1E-07	9E-07

TABLE A-65. CANCER RISK ASSOCIATED WITH THE INHALATION OF VOLATILES DURING SHOWERING BY A HYPOTHETICAL RESIDENT AT PS-7

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Chloroform	1.1E-02	1.8E-02	1.1E-06	1.3E-05	8.1E-02	9E-08	1E-06
TOTAL RISK						9E-08	1E-06

(a) Dose for the inhalation of volatiles from showering pathway have been calculated for chemicals of concern with inhalation toxicity criteria. The following chemical is not presented due to lack of inhalation toxicity criteria: bromodichloromethane.

(b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) model. These values represent the average air concentration for total shower exposure.

TABLE A-66. NONCANCER HAZARD ASSOCIATED WITH INGESTION OF GROUND WATER BY A HYPOTHETICAL RESIDENT AT PS-7

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Bromodichloromethane	0.65	1.0	1.3E-06	2.7E-05	2E-02	5E-04	1E-03
Chloroform	2.1	3.4	4.0E-06	9.3E-05	1E-02	3E-03	9E-03
HAZARD INDEX						4E-03	1E-02

TABLE A-67. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-7

CHEMICAL	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Bromodichloromethane	0.65	1.0	9.1E-07	3.5E-06	6E-02	5E-08	2E-07
Chloroform	2.1	3.4	2.9E-06	1.2E-05	6.1E-03	2E-08	7E-08
TOTAL RISK						7E-08	3E-07

TABLE A-68. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-7

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Bromodichloromethane	0.65	1.0	6.4E-06	9.8E-06	2E-02	3E-04	5E-04
Chloroform	2.1	3.4	2.1E-05	3.3E-05	1E-02	2E-03	3E-03
HAZARD INDEX						2E-03	4E-03

**TABLE A-69. CUMULATIVE CANCER RISK AT FAIRCHILD AIR FORCE
BASE SITE PS-7**

RECEPTOR/PATHWAY	AVERAGE RISK	RME RISK
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	7E-08	3E-07
CUMULATIVE RISK	7E-08	3E-07
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	1E-07	9E-07
Inhalation of Volatiles During Showering	9E-08	1E-06
CUMULATIVE RISK	2E-07	2E-06

**TABLE A-70. SUMMARY OF NONCANCER HAZARD AT FAIRCHILD AIR
FORCE BASE SITE PS-7**

RECEPTOR/PATHWAY	AVERAGE HI	RME HI
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	2E-03	4E-03
CUMULATIVE HAZARD INDEX	2E-03	4E-03
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	---	---
Ingestion of Ground Water	4E-03	1E-02
CUMULATIVE HAZARD INDEX	4E-03	1E-02

TABLE A-71. CONCENTRATIONS OF CONTAMINANTS OF CONCERN AT SITE PS-10

MEDIUM	COC	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Soil	TCE	581.1 mg/kg	18.2 mg/kg
	TPH-D	36,000 mg/kg	2,397 mg/kg

TABLE A-72. SUMMARY OF RESULTS OF LFI NON-METAL ANALYSES FOR SOIL SAMPLES AT PS-10

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS	MAXIMUM DETECTION (mg/kg)	DEPTH OF MAX. DETECTION (feet)
TPH 418.1	11/21	B-17, B-18, B-19, SS-1, & SS-5	33,224	1
VOC (SW8260)				
Trichloroethylene	15/21	B-17, B-18, B-19, SS-1, & SS-3	581	1
Benzene	1/21	SS-1	0.064	2
Toluene	4/21	B-18, SS-1	0.229	2
Ethylbenzene	2/21	B-18	0.040	2
1,1-Dichloroethane	2/21	B-18, SS-1	0.126	2
1,1-Dichloroethene	2/21	B-18	0.126	2
Tetrachloroethylene	2/21	B-18	0.033	4
Methylene Chloride	1/21	SS-1	0.018	Surface
1,1,2-Trichloroethane	1/21	SS-1	0.014	Surface
Chloroform	2/21	B-18, SS-1	0.024	2
1,1,2,2-Tetrachloroethane	3/21	B-18, SS-1	0.031	2
Total Xylenes	2/21	B-18	0.046	2
SVOC (SW8270)				
2-Methylphenol	1/21	B-18	62.5	1
2-Methylnaphthalene	1/21	B-18	0.238	4
bis(2-ethylhexyl)Phthalate	10/21	B-17, B-18, B-19, SS-1, & SS-3	13.43	1
2,4-Dimethylphenol	3/21	B-18, SS-5	54.8	1

* **BOLD** = location of maximum detection.

TABLE A-73. SUMMARY OF RESULTS OF RI NON-METAL ANALYSES FOR SOIL SAMPLES AT PS-10

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS*	MAXIMUM DETECTION (mg/kg)
TPH (E 418.1)	9/26	B-16, 17, 18, 19, SS-1 , SS-2, & B-19	36000
VOC (SW8260)			
t-Butylbenzene	2/53	B-17, 18R	0.0091
Toluene	1/53	B-20	0.00948R
p-Cymene (p-Isopropyltoluene)	3/53	B-17, 18, 18R	0.019
cis-1,2-Dichloroethane	2/53	B-20, 20R	0.017
Ethylbenzene	2/53	B-17, 20R	0.0059
Methylene Chloride	10/53	B-16, 17, 16R, 17R, 18R , 19R, 20R	0.0073
Naphthalene	3/53	B-17, 18, 18R	0.0071
1,2,3-Trichloropropane	1/53	B-20	0.0077R
1,2,4-Trimethylbenzene	6/53	B-17, 19, 20, 17R, 18R, 20R	0.11
1,3,5-Trimethylbenzene	3/53	B-19, 18R , 20R	0.13
m,p-Xylene(s)	3/53	B-17, 20R	0.047
o-Xylene	3/53	B-17, 20	0.0908R
VOC (SW8010)			
TCE	3/3	SS-1 , SS-2, B-19	73.2
SVOC (SW8270)			
bis(2-ethylhexyl)Phthalate	5/53	B-17, 18 , 19	1.20
2,4-Dimethylphenol	4/53	B-16R, 17R, 18R	27.0
Hexachloroethane	1/53	B-18	0.412

* **BOLD** = location of maximum detection.

R = Data are rejected.

**TABLE A-74. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOIL AT PS-10**

CHEMICAL	SOIL (all depths) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS						
Aluminum	15,000	---	---	---	13,000	NO
Arsenic	9	1.4	0.04	8.2	13	NO
Barium	160	5,600	---	1,900	190	NO
Cadmium	3.9	40	---	27	0.43	NO
Calcium	11,000	---	---	---	8,800	NO
Chromium (VI)	85	400	---	140	15	NO
Cobalt	34	---	---	---	14	YES
Copper	52	3,000	---	1,000	22	NO
Iron	68,000	---	---	---	34,000	NO
Lead	72	---	---	---	50	YES
Magnesium	5,900	---	---	---	53,000	NO
Manganese	1,600	400	---	3,800	670	YES
Mercury	0.12	24	---	8.2	0.05	NO
Nickel	18	1,600	---	550	13	NO
Potassium	1,900	---	---	---	2,500	NO
Sodium	940	---	---	---	600	NO
Thallium	24	5.6	---	1.9	0.25	YES
Vanadium	130	560	---	190	70	NO
Zinc	280	24,000	---	8,200	68	NO

**TABLE A-74. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOIL AT PS-10 (Continued)**

CHEMICAL	SOIL (all depths) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
ORGANICS						
Benzene	0.06	1.5	2.2	---	---	NO
t-Butylbenzene	0.01R	---	---	---	---	YES
Chloroform	0.02	160	10.5	270	---	NO
p-Cymene	0.02R	---	---	---	---	YES
1,1-Dichloroethane	0.13	8,000	---	2,700	---	NO
1,1-Dichloroethene	0.13	1.7	0.1	250	---	YES
cis-1,2-Dichloroethene	0.02R	800	---	550	---	NO
2,4-Dimethylphenol	55	1,600	---	550	---	NO
Ethylbenzene	0.04	8,000	---	2,700	---	NO
bis(2-Ethylhexyl)phthalate	13	71	4.6	550	---	YES
Hexachloroethane	0.41	71	4.6	27	---	NO
Methylene chloride	0.02	130	8.5	1,600	---	NO
Naphthalene	0.01	320	---	1,100	---	NO
1,1,2,2-Tetrachloroethane	0.03	5.0	0.3	13	---	NO
Tetrachloroethene	0.03	20	1.2	270	---	NO
Toluene	0.23	16,000	---	5,500	---	NO
Total petroleum hydrocarbons	36,000	---	---	---	---	YES
Trichloroethylene	580	90	5.8	---	---	YES
1,2,4-Trimethylbenzene	0.11	---	---	---	---	YES

**TABLE A-74. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOIL AT PS-10 (Continued)**

CHEMICAL	SOIL (all depths) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
1,3,5-Trimethylbenzene	0.13	---	---	---	---	YES
Xylenes	0.05	160,000	---	55,000	---	NO

- (a) All values rounded to two significant digits.
- (b) The screening was conservatively performed on the maximum concentration detected over all depths analyzed. Chemicals detected in surface soil will be evaluated in the exposure assessment.
- (c) The Model Toxics Control Act (MTCA) cleanup regulation (Chapter 173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (1991b), the soil RBSL for carcinogens is based on a 1×10^{-7} risk.
- (e) Based on EPA Region 10 guidance (1991b), the soil RBSL for noncarcinogens is based on a 0.1 hazard quotient.
- (f) The High Normal Background Concentrations (HNBC) were calculated and referenced in SAIC (1991a) and in Appendix J. There is no background data for organic chemicals. See text.
- (g) Potential COC include metals that exceed (or do not have) the lowest criterion presented and exceed the HNBC as well as organic compounds that exceed (or do not have) the lowest criterion presented. Chemicals without an RBSL lack toxicity criteria. Based on Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement. Based on EPA Region 10 guidance (1991b), if chromium, cadmium, elemental mercury, or carcinogenic forms of nickel are present as contaminants of concern in soil, they should not be eliminated based on soil ingestion screening criteria. However, if concentrations are less than background, they will not be evaluated further.

--- = No Value.

COC = Contaminants of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-75. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN GROUND WATER AT PS-10

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS							
Aluminum	680	---	---	---	---	16,000	NO
Barium	31	2,000	1,100	---	260	2,700	NO
Beryllium	2.3	4	0.02	0.02	20	6	NO
Cadmium	2.1	5	8	---	1.8	---	YES
Calcium	71,000	---	---	---	---	---	NO
Iron	3,200	---	---	---	---	35,000	NO
Lead	13	15 ^(h)	---	---	---	20	NO
Magnesium	20,000	---	---	---	---	---	NO
Manganese	93	---	80	---	18	1,500	NO
Potassium	2,400	---	---	---	---	---	NO
Sodium	24,000	---	---	---	---	---	NO
Zinc	42	---	4,800	---	1,100	40	NO
ORGANICS							
sec-Butylbenzene	2.0R	---	---	---	---	---	YES
cis-1,2-Dichloroethene	830	70	80	---	37	---	YES
trans-1,2-Dichloroethene	3.0	100	160	---	73	---	NO

TABLE A-75. RISK-BASED SCREENING LEVELS FOR POTENTIAL CHEMICALS OF CONCERN IN GROUND WATER AT PS-10 (Continued)

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NONCARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
bis(2-Ethylhexyl)phthalate	24	6.0	6.2	6.1	73	---	YES ⁽ⁱ⁾
Trichloroethylene	410	5	4.0	2.5	---	---	YES

(a) All values rounded to two significant digits.

(b) Federal Maximum Contaminant Levels (MCL) for drinking water.

(c) The Model Toxics Control Act (MTCA) cleanup regulation (173-340 WAC) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.

(d) Based on EPA Region 10 guidance (1991b), the ground water RBSL is based on a 1×10^{-6} risk. RBSL for volatile chemicals with an inhalation slope factor were calculated based on ingestion and inhalation of volatiles from ground water.

(e) Based on EPA Region 10 guidance (1991b), the ground water RBSL for noncarcinogens is based on a 0.1 hazard quotient. RBSL for volatile chemicals with inhalation reference doses were calculated based on ingestion and inhalation of volatiles from ground water.

(f) High Normal Background Concentrations were calculated and referenced in SAIC (1991) and in Appendix J.

(g) Potential chemicals of concern include chemicals that exceed (or do not have) the lowest criterion presented and that exceed background concentration. However, based on EPA Region 10 guidance (1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.

(h) Action level: exceeded if the level of concentration in more than 10% of targeted tap samples is greater than the specified value (90th percentile).

(i) Chosen as a potential contaminant of concern; however, presence of this contaminant may be due to blank contamination.

--- = No Value.

COC = Contaminants of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-76. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER BY A HYPOTHETICAL RESIDENT AT PS-10

CHEMICAL (a)	AVERAGE EXPOSURE POINT CONCENTRATION ($\mu\text{g/L}$)	RME EXPOSURE POINT CONCENTRATION ($\mu\text{g/L}$)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
cis-1,2-Dichloroethene	270	830	4.1E-03	2.3E-02	1E-02	4E-01	2E+00
bis(2-Ethylhexyl)phthalate	9.8	24	1.5E-04	1.0E-03	2E-02	7E-03	3E-02
Cadmium	0.001 ^(b)	2	1.5E-08	5.5E-05	5E-04	3E-05	1E-01
HAZARD INDEX						4E-01	2E+00

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses.

(b) The maximum detect for cadmium was less than the detection limit for some samples. Therefore, the average exposure point concentration was calculated without using a nondetect value that was greater than the maximum detect.

TABLE A-77. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR A HYPOTHETICAL RESIDENT AT PS-10

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL CANCER SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Trichloroethene	155	410	3.0E-04	5.0E-03	1.1E-02	3E-06	5E-05
CANCER RISK						3E-06	5E-05

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: cadmium, cis-1,2-dichloroethene and bis(2-ethylhexyl)phthalate. Although the trichloroethene slope factor was withdrawn by EPA, the Environmental Criteria and Assessment Office (ECAO) indicates that the withdrawn slope factor may be used to conservatively estimate cancer risk for trichloroethene.

TABLE A-78. CANCER RISK ASSOCIATED WITH THE INHALATION OF VOLATILES DURING SHOWERING FOR A HYPOTHETICAL RESIDENT AT PS-10

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Trichloroethene	7.9E-01	2.9E+00	7.9E-05	2.0E-03	1.4E-02	1E-06	3E-05
CANCER RISK						1E-06	3E-05

- (a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack to toxicity criteria: cadmium, cis-1,2-dichloroethene and bis(2-ethylhexyl)phthalate. Although the trichloroethene slope factor was withdrawn by EPA, the Environmental Criteria and Assessment Office (ECAO) indicates that the withdrawn slope factor may be used to conservatively estimate cancer risk for trichloroethene.
- (b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) shower model. These values represent the average and RME air concentration for total shower exposure.

TABLE A-79. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-10

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (μg/L)	RME EXPOSURE POINT CONCENTRATION (μg/L)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
cis-1,2-Dichloroethene	270	830	2.6E-03	8.1E-03	1E-02	3E-01	8E-01
bis(2-Ethylhexyl)phthalate	9.8	24	9.6E-05	2.3E-04	2E-02	5E-03	1E-02
Cadmium	0.001 ^(b)	2	1.0E-08	2.0E-05	5E-04	2E-05	4E-02
HAZARD INDEX						3E-01	8E-01

- (a) Ground water ingestion doses have been calculated for those chemicals of concern with oral reference doses.
- (b) The maximum detect for cadmium was less than the detection limit for some samples. Therefore, the average exposure point concentration was calculated without using a nondetect value that was greater than the maximum detect.

TABLE A-80. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-10

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL CANCER SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Trichloroethene	155	410	2.0E-04	1.4E-03	1.1E-02	2E-06	2E-05
CANCER RISK						2E-06	2E-05

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: cadmium, cis-1,2-dichloroethene and bis(2-ethylhexyl)phthalate. Although the trichloroethene slope factor was withdrawn by EPA, the Environmental Criteria and Assessment Office (ECAO) indicates that the withdrawn slope factor may be used to conservatively estimate cancer risk for trichloroethene.

TABLE A-81. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT PS-10^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
1,1-Dichloroethene	0.0023	0.0025	2.4E-09	9.2E-09	9E-03	3E-07	1E-06
bis(3-Ethylhexyl) phthalate	0.42	13	4.4E-07	5.0E-05	2E-02	2E-05	3E-03
Manganese	496	560	1.0E-03	2.1E-03	5E-03	2E-01	4E-01
Thallium	8.4 ^(c)	24 ^(c)	9.1E-06	8.9E-05	8E-05	1E-01	1E+00
HAZARD INDEX						3E-01	2E+00

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Soil ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals of concern are not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; lead; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

(c) Thallium is thought to be an artifact from sampling. See text.

TABLE A-82. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT PS-10^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
1,1-Dichloroethene	0.0023	0.0024	3.2E-10	3.8E-09	6E-01	2E-10	2E-09
bis(2-Ethylhexyl) phthalate	0.42	13	5.8E-06	2.0E-05	1.4E-02	8E-10	3E-07
Trichloroethene	18	580	2.5E-06	9.0E-04	1.1E-02	3E-08	1E-05
TOTAL RISK						3E-08	1E-05

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Soil ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals of concern are not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; lead; manganese; thallium; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-83. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-10^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
1,1-Dichloroethene	0.0023	0.0025	1.1E-09	1.2E-09	9E-03	1E-07	1E-07
bis(3-Ethylhexyl) phthalate	0.42	13	2.1E-07	6.5E-06	2E-02	1E-05	3E-04
Manganese	496	560	2.4E-04	2.7E-04	5E-03	5E-02	5E-02
Thallium	8.4 ^(c)	24 ^(c)	4.1E-06	1.2E-05	8E-05	5E-02	1E-01
HAZARD INDEX						1E-01	2E-01

- (a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.
- (b) Soil ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemicals of concern are not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; lead; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.
- (c) Thallium is thought to be an artifact from sampling. See text.

TABLE A-84. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/ CONTRACTORS AT PS-10^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
1,1-Dichloroethene	0.0023	0.0024	1.6E-10	4.0E-10	6E-01	1E-10	2E-10
bis(2-Ethylhexyl) phthalate	0.42	13	2.9E-08	2.3E-06	1.4E-02	4E-10	3E-08
Trichloroethene	18	580	1.2E-06	1.0E-04	1.1E-02	1E-08	1E-06
TOTAL RISK						1E-08	1E-06

- (a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.
- (b) Soil ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals of concern are not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; lead; manganese; thallium; total petroleum hydrocarbons; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-85. NONCANCER HAZARD ASSOCIATED WITH THE INHALATION OF SOIL BY A HYPOTHETICAL RESIDENT AT PS-10^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	INHALATION REFERENCE DOSE (RfD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Manganese	496	560	2.3E-09	3.3E-08	1.43E-05	2E-04	2E-03
HAZARD INDEX						2E-04	2E-03

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Inhalation of surface soil doses were calculated for those chemicals of concern with inhalation reference doses. The following chemicals of concern were not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; 1,1-dichloroethene; bis(2-ethylhexyl)phthalate; lead; thallium; total petroleum hydrocarbons; trichloroethene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-86. CANCER RISK ASSOCIATED WITH THE INHALATION OF SOIL BY A HYPOTHETICAL RESIDENT^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
1,1-Dichloroethene	0.0023	0.0025	1.3E-14	6.3E-14	1.75E-01	2E-15	1E-14
TOTAL RISK						2E-15	1E-14

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Inhalation of surface soil doses were calculated for those chemicals of concern with inhalation cancer slope factors. The following chemicals of concern were not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; bis(2-ethylhexyl)phthalate; lead; manganese; thallium; total petroleum hydrocarbons; trichloroethene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-87. NONCANCER HAZARD ASSOCIATED WITH THE INHALATION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT PS-10^(a)

CHEMICAL ^(b)	Average Exposure Point Concentration (mg/kg)	RME Exposure Point Concentration (mg/kg)	Average Average Daily Dose (ADD) (mg/kg-day)	RME Average Daily Dose (ADD) (mg/kg-day)	Inhalation Reference Dose (RfD) (mg/kg-day)	Average Hazard Quotient	RME Hazard Quotient
Manganese	496	560	2.1E-08	2.4E-08	1.43E-05	1E-03	2E-03
HAZARD INDEX						1E-03	2E-03

- (a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.
- (b) Inhalation of surface soil doses were calculated for those chemicals of concern with inhalation reference doses. The following chemicals of concern were not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; 1,1-dichloroethene; bis(2-ethylhexyl)phthalate; lead; thallium; total petroleum hydrocarbons; trichloroethene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-88. CANCER RISK ASSOCIATED WITH THE INHALATION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS^(a)

Chemical ^(b)	Average Exposure Point Concentration (mg/kg)	RME Exposure Point Concentration (mg/kg)	Average Lifetime Average Daily Dose (LADD) (mg/kg-day)	RME Lifetime Average Daily Dose (LADD) (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) ⁻¹	Average Carcinogenic Risk	RME Carcinogenic Risk
1,1-Dichloroethene	0.0023	0.0025	1.4E-14	3.8E-14	1.75E-01	2E-15	7E-15
TOTAL RISK						2E-15	7E-15

- (a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.
- (b) Inhalation of surface soil doses were calculated for those chemicals of concern with inhalation cancer slope factors. The following chemicals of concern were not presented due to lack of toxicity criteria: t-butylbenzene; cobalt; p-cymene; bis(2-ethylhexyl)phthalate; lead; manganese; thallium; total petroleum hydrocarbons; trichloroethene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

**TABLE A-89. SUMMARY OF NONCANCER HAZARD AT FAIRCHILD AIR FORCE
BASE SITE PS-10**

RECEPTOR/PATHWAY	AVERAGE HI	RME HI
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	1E-03	2E-03
Ingestion of Soil	1E-01	2E-01
Ingestion of Ground Water	3E-01	8E-01
CUMULATIVE HAZARD INDEX	4E-01	1E+00
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	2E-04	2E-03
Ingestion of Soil	3E-01	1E+00
Ingestion of Ground Water	4E-01	2E+00
Inhalation of Volatiles During Showering	---	---
CUMULATIVE HAZARD INDEX	7E-01	3E+00

**TABLE A-90. CUMULATIVE CANCER RISK AT FAIRCHILD AIR FORCE
BASE SITE PS-10**

RECEPTOR/PATHWAY	AVERAGE RISK	RME RISK
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	2E-15	7E-15
Ingestion of Soil	1E-08	1E-06
Ingestion of Ground Water	2E-06	2E-05
CUMULATIVE CANCER RISK	2E-06	2E-05
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	2E-15	1E-14
Ingestion of Soil	5E-08	1E-05
Ingestion of Ground Water	3E-06	5E-05
Inhalation of Volatiles During Showering	1E-06	3E-05
CUMULATIVE CANCER RISK	4E-06	9E-05

TABLE A-91. RESULTS OF SAMPLING AT SITE SW-11

MEDIUM	ANALYTE	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Soil	Arsenic	12.0 mg/kg	5.95 mg/kg
	Cadmium	158 mg/kg	14.37 mg/kg
	Chromium	35.0 mg/kg	35 mg/kg
	Cobalt	13.5 mg/kg	6.3 mg/kg
	Copper	1,230 mg/kg	1,230 mg/kg
	Lead	1,340 mg/kg	116.1 mg/kg
	Nickel	37.0 mg/kg	37 mg/kg

There are no chemical chemicals of concern at this site. The metallic debris that lies beneath the hard pan at this site is a physical hazard, not a CERCLA risk to human health and the environment. Because the nature of the risk posed by this site differs from the other sites, SW-11 has not been evaluated in the strict manner of a CERCLA or IRP site. The risks posed by SW-11 are mainly physical hazards from sharp metallic debris at or near the surface, and valves located near the surface that may contain small amounts of reactive sodium. The metallic debris is not subject to transportation or degradation. Evidence of corrosion among buried valves has been gathered. Corrosion will gradually expose the sodium, allowing it to react with water in small amounts. Once the reaction has occurred, the sodium forms sodium hydroxide (NaOH), a strong base. Percolating rainwater will rapidly dilute the small amount of NaOH to the point where it is harmless.

**TABLE A-92. SUMMARY OF RI METALS DETECTION DATA FOR SOIL SAMPLES
AT SW-11 (MARCH 1993)**

METAL ANALYTE ^(a)	NUMBER OF DETECTIONS/ ANALYSES	DETECTIONS > SW-11 HNBC		
		NUMBER OF DETECTION ABOVE SW-11 HNBC/ANALYSES	LOCATIONS ^(b)	MAXIMUM DETECTION (mg/kg)
Al	33/34	8/34	B-26, 27, 30, 32	24,567
As (SW7060)	33/34	4/34	B-26, 30, 30R	11.8
Ba	34/34	0/34	B-27, 30, 32	256.3J
Cd (SW7131)	34/34	16/34	B-25, 26, 27, 28, 29, 30, 31, 32	158
Ca	34/34	0/34	N/A	N/A
Cr (SW7191)	34/34	9/34	B-25, 26, 27, 30, 32	35.2J
Co	31/34	1/34	B-28	9.71
Cu	34/34	5/34	B-27, 30	1,234J
Fe	34/34	5/34	B-25, 27, 28, 32	25,400
Pb (SW7421)	34/34	8/34	B-25, 26, 27, 28, 30, 32	1,338
Mg	34/34	6/34	B-25, 26, 27, 28, 29, 31, 32	5,992
Mn	34/34	3/34	B-25, 27, 30	488
Ni	34/34	3/34	B-27, 30	37.2
K	34/34	4/34	B-26, 27	2,619
Na	34/34	0/34	N/A	N/A
V	34/34	2/34	B-28	44.1
Zn	34/34	10/34	B-25, 26, 27, 28, 29, 30, 32	427

(a) All analyses by ICP (SW6010) unless otherwise noted.

(b) **BOLD** = Location of maximum detection.

HNBC = Site SW-11 High Normal Background Concentration (see Appendix J).

J = Data are estimates.

N/A = Not Applicable.

**TABLE A-93. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOILS AT SW-11**

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)						
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	SW-11 HNBC ^(f)	BASEWIDE HNBC	POTENTIAL COC ^(g)
INORGANICS							
Aluminum	24,600	---	---	---	11,200	13,100	NO
Arsenic	11.0	1.4	0.04	8.2	8.7	12.6	YES
Barium	168	5,600	---	1,900	172	191	NO
Cadmium	158	40	---	27	0.327	0.432	YES
Calcium	16,400	---	---	---	20,100	8,780	NO
Chromium	35.0	400	---	140	9.6	15.2	NO
Cobalt	9.14	---	---	---	9.1	13.9	NO
Copper	1,230	3,000	---	1,000	43.7	21.6	YES
Iron	25,400	---	---	---	22,200	34,500	NO
Lead	1,340	---	---	---	19.8	50.4	YES
Magnesium	5,990	---	---	---	4,760	5,340	NO
Manganese	488	400	---	3,800	473	669	NO
Nickel	37.0	1,600	---	550	11.8	13.4	NO
Potassium	2,620	---	---	---	2,070	2,490	NO
Sodium	780	---	---	---	410	604	NO

**TABLE A-93. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOIL AT SW-11 (Continued)**

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)						
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	SW-11 HNBC ^(f)	BASEWIDE HNBC	POTENTIAL COC ^(g)
Vanadium	44.0	560	---	190	40.6	69.4	NO
Zinc	427	24,000	---	8,200	52.2	68.3	NO

- (a) All values rounded to three significant digits.
- (b) The screening was conservatively performed on the maximum concentration detected over all depths analyzed. Chemicals detected in surface soil will be evaluated in the exposure assessment.
- (c) The Model Toxics Control Act cleanup regulation (Ecology 1991) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (EPA 1991b), the soil RBSL for carcinogens is based on a 1×10^{-7} risk.
- (e) Based on EPA Region 10 guidance (EPA 1991b), the soil RBSL for non-carcinogens is based on a 0.1 hazard quotient.
- (f) The High Normal Background Concentrations were calculated and referenced in SAIC (SAIC 1991a). There is no background data for organic chemicals.
- (g) Potential contaminants of concern include metals that exceed (or do not have) the lowest criterion presented and that exceed background UTL as well as organic compounds that exceed (or do not have) the lowest criterion presented. Chemicals without an RBSL lack toxicity criteria. Based on EPA Region 10 guidance (EPA 1991), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement. Based on EPA Region 10 guidance, if chromium, cadmium, elemental mercury, or carcinogenic forms of nickel are present as contaminants of concern in soil, they should not be eliminated based on soil ingestion screening criteria. However, if concentrations are less than background, they will not be evaluated further.
- (h) Chosen as a potential contaminant of concern; however, presence of this contaminant may be due to blank contamination.

--- = No Value.

COC = Contaminant of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-94. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT SW-11^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Arsenic	5.9	7.8	6.2E-06	2.9E-05	3E-04	2E-02	1E-01
Cadmium	14.4	70	1.5E-05	2.6E-04	5E-04	3E-02	5E-01
Copper	197	365	2.1E-04	1.4E-03	4E-02	5E-03	3E-02
HAZARD INDEX						6E-02	6E-01

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Ingestion of soil doses have been calculated for those chemicals of concern with oral reference doses. The following chemical is not presented due to lack of toxicity criteria: lead.

TABLE A-95. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT SW-11^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Arsenic	5.9	7.8	2.7E-06	3.8E-06	3E-04	9E-03	1E-02
Cadmium	14.4	70	7.0E-06	3.4E-05	5E-04	1E-02	7E-02
Copper	197	365	9.6E-05	1.8E-04	4E-02	2E-03	5E-03
HAZARD INDEX						2E-02	8E-02

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Soil ingestion doses have been calculated for those chemicals of concern with oral reference doses. The following chemical is not presented due to lack of toxicity criteria: lead.

**TABLE A-96. NONCANCER HAZARD ASSOCIATED WITH DERMAL CONTACT WITH SOIL BY A
HYPOTHETICAL RESIDENT AT SW-11^(a)**

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Cadmium	14.4	70	1.2E-05	5.5E-05	5E-04	3E-03	1E-01
HAZARD INDEX						3E-03	1E-01

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Dermal contact with soil doses has been calculated for those chemicals of concern with dermal absorption information. The following chemicals are not presented due to lack of toxicity criteria: arsenic, copper and lead. The dermal absorption used for cadmium is 1% (EPA 1992 - Dermal Guidance).

**TABLE A-97. NONCANCER HAZARD ASSOCIATED WITH DERMAL CONTACT WITH SOIL BY AIR FORCE
PERSONNEL/CONTRACTORS AT SW-11^(a)**

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Cadmium	14.4	70	4.9E-07	4.2E-06	5E-04	1E-03	8E-03
HAZARD INDEX						1E-03	8E-03

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Dermal contact with soil doses has been calculated for those chemicals of concern with dermal absorption information. The following chemicals are not presented due to lack of toxicity criteria: arsenic, copper and lead. The dermal absorption used for cadmium is 1% (EPA 1992 - Dermal Guidance).

TABLE A-98. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT SW-11^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Arsenic	5.9	7.8	8.1E-07	1.2E-05	1.75E+00	1E-06	2E-05
TOTAL RISK						1E-06	2E-05

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Ingestion of soil doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: cadmium, copper and lead.

TABLE A-99. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT SW-11^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Arsenic	5.9	7.8	4.0E-07	1.3E-06	1.75E+00	7E-07	2E-06
TOTAL RISK						7E-07	2E-06

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Soil ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemical is not presented due to lack of toxicity criteria: cadmium, copper and lead.

TABLE A-100. CANCER RISK ASSOCIATED WITH THE INHALATION OF SOIL BY A HYPOTHETICAL RESIDENT AT SW-11^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Arsenic	5.9	7.8	3.5E-11	2.0E-10	1.5E+01	5E-10	3E-09
Cadmium	14.4	70	8.6E-11	1.8E-09	6.3E+00	5E-10	1E-08
TOTAL RISK						1E-09	1E-08

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Inhalation of soil doses have been calculated for those chemicals of concern with inhalation cancer slope factors. The following chemicals are not presented due to lack of toxicity criteria: copper and lead.

TABLE A-101. CANCER RISK ASSOCIATED WITH THE INHALATION OF SURFACE SOIL PARTICULATES BY AIR FORCE PERSONNEL/CONTRACTORS AT SW-11^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Arsenic	5.9	7.8	3.5E-11	1.2E-10	1.5E+01	5E-10	2E-09
Cadmium	14	70	8.6E-11	1.0E-09	6.3E+00	5E-10	6E-09
TOTAL RISK						1E-09	8E-09

(a) Surface and subsurface soil were combined to evaluate this scenario where data was available and useable.

(b) Inhalation of soil particulate doses have been calculated for those chemicals of concern with inhalation slope factors. The following chemicals are not presented due to lack of toxicity criteria: copper and lead.

**TABLE A-102. CUMULATIVE CANCER RISK AT FAIRCHILD AIR FORCE
BASE SITE SW-11**

RECEPTOR/PATHWAY	AVERAGE RISK	RME RISK
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	1E-09	8E-09
Ingestion of Soil	7E-07	2E-06
Dermal Contact with Soil	---	---
Ingestion of Groundwater	---	---
CUMULATIVE RISK	7E-07	2E-06
Residential Exposure Under Current Conditions		
Inhalation of Soil Particulate	1E-09	1E-08
Ingestion of Soil	1E-06	2E-05
Dermal Contact with Soil	---	---
Ingestion of Groundwater	---	---
Inhalation of Volatiles During Showering	---	---
CUMULATIVE RISK	1E-06	2E-05

**TABLE A-103. SUMMARY OF NONCANCER HAZARD AT FAIRCHILD
AIR FORCE BASE SITE SW-11**

RECEPTOR/PATHWAY	AVERAGE HI	RME HI
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	2E-02	8E-02
Dermal Contact with Soil	1E-03	8E-03
Ingestion of Groundwater	---	---
CUMULATIVE HAZARD INDEX	2E-02	9E-02
Residential Exposure Under Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	6E-02	6E-01
Dermal Contact with Soil	3E-03	1E-01
Ingestion of Groundwater	---	---
Inhalation of Volatiles During Showering	---	---
CUMULATIVE HAZARD INDEX	6E-02	7E-01

TABLE A-104. CONCENTRATIONS OF CONTAMINANTS OF CONCERN AT SITE FT-2

MEDIUM	COC	MAXIMUM CONCENTRATION	AVERAGE CONCENTRATION
Soil	TPH-D	5,400 mg/kg	410.1 mg/kg
	TPH-G	640 mg/kg	114.07 mg/kg
Ground water	TPH	22,000 μ g/L	22,000 μ g/L

TABLE A-105. SUMMARY OF RI NON-METALS SOIL ANALYSES RESULTS AT FT-2

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS	MAXIMUM DETECTION (mg/kg)
TPH (E 418.1)	14/34	B-23, 36, 37, MW-209, 211, 212, S-08, 09, 10, 11, 12, 13	5398
TPH-D. Gasoline (CA 8015)	7/14 ^(a)	B-45R	640
TPH-D. Diesel (CA 8015)	4/14 ^(b)	B-45R	4500
VOC (SW 8260)			
n-Butylbenzene	5/44	B-45R	6.00
sec-Butylbenzene	4/44	B-45R	3.10
Benzene	1/44	B-23	0.63R
Toluene	12/44	B-22, 23, 36, 45R, S-08, 09, 12, 13	12.0
p-Cymene (p- Isopropyltoluene)	7/44	B-23, 45R, S-09	2.5
1,1-Dichloroethane	1/44	B-45R	0.03
1,2-Dichloroethane	1/44	S-10	0.01R
1,4-Dichlorobenzene	3/44	B-23, S-09, 10	0.15R
cis-1,2-Dichloroethylene	2/44	B-45R	0.09
Ethylbenzene	11/44	B-23, 45R, S-08, 09, 13	8.4
Methylene Chloride	10/44	B-23, 45R, S-08, 10, 12, 13	0.68
Naphthalene	6/44	B-23, 45R	4.8
n-Propylbenzene	5/44	B-45R	6.00
Pentafluorobenzene	1/44	B-39	0.06R
1,1,2,2-Tetrachloroethane	2/44	B-23	31.8R
1,2,3-Trichlorobenzene	1/44	B-36	0.01R
1,2,4-Trichlorobenzene	1/44	B-37	0.01R
Trichloroethylene	4/44	B-45, 45R, S-10	1.30
1,2,4-Trimethylbenzene	14/44	B-23, 45R, S-08, 09, 10, 11, 12, 13	44.4
1,3,5-Trimethylbenzene	11/44	B-21, 23, 45, 45R, S-09	11.0
m,p-Xylene(s)	12/44	B-23, 45R, S-08, 09, 12, 13	34.0
o-Xylene	14/44	B-23, 45R, S-08, 09, 11, 12, 13	18.0
1-Methylethylbenzene	3/44	B-45R	2.5

**TABLE A-105. SUMMARY OF RESULTS OF NON-METALS SOIL ANALYSES
SAMPLES AT FT-2 (Continued)**

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS	MAXIMUM DETECTION (mg/kg)
SVOC (SW 8270)			
bis(2-Ethylhexyl)Phthalate	3/41	MW-209, 210, 211, 212	0.53
4-Methylphenol	1/44	B-45R	0.47
2-Methylnaphthalene	5/44	B-21, 23, 45R	46.4
Naphthalene	3/44	B-23, 45R	35.1
Pentachlorophenol	1/44	S-11	1.28

- (a) Includes one detection noted by the laboratory as "Unknown Volatile Hydrocarbon."
 (b) All detections noted by the laboratory as "Unknown Extractable Hydrocarbon."

BOLD = Location of maximum detection.
R = Data are rejected.

**TABLE A-106. SUMMARY OF RI NON-METALS GROUND WATER RESULTS
ANALYSES AT FT-2**

ANALYTE	NUMBER OF DETECTIONS/ ANALYSES	LOCATIONS	MAXIMUM DETECTION (μ g/L)
TPH-D (CA 8015)	10/20	MW-209, 210, 211, 212	22,000J
VOC (SW 8260)			
sec-Butylbenzene	7/20	MW-210	3.60
Carbon Tetrachloride	3/20	MW-209	1.60
1,1-Dichloroethane	9/20	MW-210, 212	8.00
1,1-Dichloroethylene	4/20	MW-210, 211, 212	2.40
cis-1,2-Dichloroethylene	11/20	MW-210, 211, 212	31.0
Pentafluorobenzene	1/20	MW-210	10.6R
SVOC (SW 8270)			
Dimethylphthalate	1/20	MW-211	20.0
EDB (SW 8011)	0/15	N/A	N/A

BOLD = Location of maximum detection.

R = Data are rejected.

N/A = Not applicable.

**TABLE A-107. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOILS AT FT-2**

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	FT-2 HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS						
Aluminum	30,000	---	---	---	15,000	NO
Arsenic	8.0	1.4	0.04	8.2	10	NO
Barium	540	5,600	---	1,900	270	NO
Cadmium	15	40	---	27	2.2	NO
Calcium	9,300	---	---	---	8,300	NO
Chromium	44	400	---	140	19	NO
Cobalt	79	---	---	---	14	YES
Copper	1,200	3,000	---	1,000	25	YES
Iron	50,000	---	---	---	44,000	NO
Lead	1,500	---	---	---	400	YES
Magnesium	6,000	---	---	---	4,400	NO
Manganese	780	400	---	3,800	1,000	NO
Molybdenum	38	400	---	---	2	NO
Nickel	250	1,600	---	550	12	NO
Potassium	2,300	---	---	---	3,200	NO
Silver	2.0	240	---	140	0.5	NO
Sodium	780	---	---	---	750	NO
Vanadium	140	560	---	190	94	NO
Zinc	550	24,000	---	8,200	100	NO
ORGANICS						
n-Butylbenzene	6.0	---	---	---	---	YES
sec-Butylbenzene	3.1	---	---	---	---	YES
p-Cymene	3.0	---	---	---	---	YES
1,1-Dichloroethane	0.03	8,000	---	2,700	---	NO

**TABLE A-107. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN
IN SOIL AT FT-2 (Continued)**

CHEMICAL	SOIL (ALL DEPTHS) (mg/kg) ^(a)					
	MAXIMUM CONCENTRATION ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	FT-2 HNBC ^(f)	POTENTIAL COC ^(g)
cis-1,2-Dichloroethylene	0.09	800	---	550	---	NO
bis(2-Ethylhexyl)phthalate	0.53	71	4.6	550	---	NO
Ethylbenzene	8.0	8,000	---	2,700	---	NO
Isopropylbenzene	3.0	---	---	1,100	---	NO
Methylene chloride	0.68	130	8.5	1,600	---	NO
2-Methylnaphthalene	46	---	---	---	---	YES
4-Methylphenol	0.47	---	---	1,400	---	NO
Naphthalene	35	320	---	1,100	---	NO
Pentachlorophenol	1.0	8.3	0.5	820	---	YES
n-Propylbenzene	6.0	---	---	---	---	YES
Toluene	12	16,000	---	5,500	---	NO
Total petroleum hydrocarbons	5,400	---	---	---	---	YES
Trichloroethylene	1.0	91	5.8	200	---	NO
1,2,4-Trimethylbenzene	44	---	---	---	---	YES
1,3,5-Trimethylbenzene	11	---	---	---	---	YES
Xylenes	52	160,000	---	55,000	---	NO

- (a) All values rounded to two significant digits
- (b) The screening was conservatively performed on the maximum concentration detected over all depths analyzed. Chemicals detected in surface soil will be evaluated in the exposure assessment.
- (c) The Model Toxics Control Act cleanup regulation (Ecology 1991) Method B is intended to provide conservative cleanup levels for sites undergoing cleanup. Based on the lowest calculated value using carcinogenic and non-carcinogenic toxicity criteria.
- (d) Based on EPA Region 10 guidance (EPA 1991b), the soil RBSL for carcinogens is based on a 1×10^{-7} risk.
- (e) Based on EPA Region 10 guidance (EPA 1991b), the soil RBSL for non-carcinogens is based on a 0.1 hazard quotient.
- (f) The Site FT-2 High Normal Background Concentrations are calculated in Appendix J. There is no background data for organic chemicals.
- (g) Potential contaminants of concern include metals that exceed (or do not have) the lowest criterion presented and that exceed background UTL, as well as organic compounds that exceed (or do not have) the lowest criterion presented. Chemicals without an RBSL lack toxicity criteria. Based on EPA Region 10 guidance (EPA 1991), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement. Based on EPA Region 10 guidance, if chromium, cadmium, elemental mercury, or carcinogenic forms of nickel are present as contaminants of concern in soil, they should not be eliminated based on soil ingestion screening criteria. However, if concentrations are less than background, they will not be evaluated further.

--- = No Value
COC = Contaminant of Concern
RBSL = Risk-Based Screening Level.

**TABLE A-108. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN
GROUND WATER AT FT-2**

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
INORGANICS							
Aluminum	2,400	---	---	---	---	16,000	NO
Barium	150	2,000	1,100	---	260	2,700	NO
Cadmium	0.70	5	8	---	1.8	---	NO
Calcium	51,000	---	---	---	---	---	NO
Iron	16,000	---	---	---	---	35,000	NO
Lead	11	15 ^(h)	---	---	---	20	NO
Magnesium	18,000	---	---	---	---	---	NO
Manganese	2,400	---	80	---	18	1,500	YES
Nickel	76	---	320	---	73	350	NO
Potassium	3,800	---	---	---	---	---	NO
Silver	16	50	48	---	18	5	NO
Sodium	26,000	---	---	---	---	---	NO
Vanadium	10	---	110	---	26	330	NO
Zinc	67	---	4,800	---	1,100	40	NO
ORGANICS							
sec-Butylbenzene	2.2	---	---	---	---	---	YES
Carbon Tetrachloride	1.6	5	0.34	0.7	2.6	---	YES
1,1-Dichloroethane	8.0	5	800	---	100	---	NO
1,1-Dichloroethylene	2.4	7	0.07	0.02	33	---	YES

TABLE A-108. RISK-BASED SCREENING LEVELS FOR POTENTIAL CONTAMINANTS OF CONCERN IN GROUND WATER AT FT-2 (Continued)

CHEMICAL	GROUND WATER ($\mu\text{g/L}$) ^(a)						
	MAXIMUM CONCENTRATION	MCL ^(b)	MTCA METHOD B ^(c)	RBSL CARCINOGENS ^(d)	RBSL NON-CARCINOGENS ^(e)	HNBC ^(f)	POTENTIAL COC ^(g)
cis-1,2-Dichloroethylene	31	70	80	---	73	---	NO
Dimethylphthalate	20	---	16,000	---	36,000	---	NO
Total petroleum hydrocarbons	22,000	---	---	---	---	---	YES

(a) All values rounded to two significant digits.

(b) Federal Maximum Contaminant Levels (MCL) for drinking water.

(c) The Model Toxics Control Act cleanup regulation (Ecology 1991) Method B is intended to provide conservative cleanup levels for site undergoing cleanup. Based on the lowest-calculated value using carcinogenic and non-carcinogenic toxicity criteria.

(d) Based on EPA Region 10 guidance (EPA 1991b), the ground water RBSL for carcinogens is based on a 1×10^{-6} risk. RBSLs for volatile chemicals with an inhalation slope factor were calculated based on ingestion and inhalation of volatiles from ground water.

(e) Based on EPA Region 10 guidance (EPA 1991b), the ground water RBSL for non-carcinogens is based on a 0.1 hazard quotient. RBSLs for volatile chemicals with inhalation reference doses were calculated based on ingestion and inhalation of volatiles from ground water.

(f) The Site FT-2 High Normal Background Concentrations (HNBC) were calculated and Referenced in Appendix J. There is no background for organic chemicals. Cadmium was not detected during background studies.

(g) Potential contaminants of concern include chemicals that exceed (or do not have) the lowest criterion presented and that exceed background concentrations. However, based on EPA Region 10 guidance (EPA 1991b), aluminum, calcium, magnesium, potassium, iron, and sodium may generally be eliminated from the human health risk assessment at the screening stage based on qualitative judgement.

(h) Action level: exceeded if the level of concentration in more than 10% of targeted tap samples is greater than the specified value (90th percentile).

--- = No Value.

COC = Contaminant of Concern.

RBSL = Risk-Based Screening Level.

TABLE A-109. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT FT-2^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Copper	160	240	7.8E-05	1.7E-04	4E-02	4E-03	2E-02
Pentachlorophenol	0.52	0.53	2.5E-07	2.6E-07	3E-02	2E-05	6E-05
HAZARD INDEX						4E-03	2E-02

(a) Surface and subsurface soil were combined to evaluate this scenario.

(b) Soil ingestion doses have been calculated for those chemicals with oral reference doses. The following chemicals are not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; cobalt; p-cymene; lead; 2-methyl naphthalene; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-110. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY A HYPOTHETICAL RESIDENT AT FT-2^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Pentachlorophenol	0.52	0.53	7.2E-08	8.3E-07	1.2E-01	9E-09	1E-07
TOTAL RISK						9E-09	1E-07

(a) Surface and subsurface soil were combined to evaluate this scenario.

(b) Soil ingestion doses have been calculated for those chemicals with oral slope factors. The following chemicals are not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; cobalt; copper; p-cymene; lead; 2-methyl naphthalene; nickel; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-111. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT FT-2^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Copper	160	240	7.8E-05	1.7E-04	4E-02	2E-03	3E-03
Pentachlorophenol	0.52	0.53	2.5E-07	2.6E-07	3E-02	8E-06	9E-06
HAZARD INDEX						2E-03	3E-03

(a) Surface and subsurface soil were combined to evaluate this scenario.

(b) Soil ingestion doses have been calculated for those chemicals with oral reference doses. The following chemicals are not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; cobalt; p-cymene; lead; 2-methyl naphthalene; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-112. CANCER RISK ASSOCIATED WITH THE INGESTION OF SOIL BY AIR FORCE PERSONNEL/CONTRACTORS AT FT-2^(a)

CHEMICAL ^(b)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/kg)	RME EXPOSURE POINT CONCENTRATION (mg/kg)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Pentachlorophenol	0.52	0.53	3.6E-08	9.3E-08	1.2E-01	4E-09	1E-08
TOTAL RISK						4E-09	1E-08

(a) Surface and subsurface soil were combined to evaluate this scenario.

(b) Soil ingestion doses have been calculated for those chemicals with oral slope factors. The following chemicals are not presented due to lack of toxicity criteria: sec-butylbenzene; n-butylbenzene; cobalt; copper; p-cymene; lead; 2-methyl naphthalene; nickel; n-propylbenzene; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene.

TABLE A-113. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR A HYPOTHETICAL RESIDENT AT FT-2

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Carbon tetrachloride	0.67	0.81	1.0E-05	2.2E-05	7E-04	1E-02	3E-02
1,1-Dichloroethene	0.70	0.88	1.1E-05	2.4E-05	9E-03	1E-03	3E-03
Manganese	883	2,290	1.3E-02	6.3E-02	5E-03	3E+00	1E+01
Nickel	24	27.7	3.6E-04	8.0E-04	2E-02	2E-02	4E-02
HAZARD INDEX						3E+00	1E+01

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral toxicity criteria. The following chemical is not presented due to lack of oral toxicity criteria: sec-butylbenzene.

TABLE A-114. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR A HYPOTHETICAL RESIDENT AT FT-2

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Carbon tetrachloride	0.67	0.81	1.3E-06	9.5E-06	1.3E-01	2E-07	1E-06
1,1-Dichloroethene	0.70	0.88	1.4E-06	1.0E-05	6E-01	8E-07	6E-06
TOTAL RISK						1E-06	7E-06

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of oral toxicity criteria: manganese, nickel and sec-butylbenzene.

TABLE A-115. CANCER RISK ASSOCIATED WITH THE INHALATION OF VOLATILES DURING SHOWERING BY A HYPOTHETICAL RESIDENT AT FT-2

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	RME EXPOSURE POINT CONCENTRATION (mg/m ³) ^(b)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	INHALATION SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Carbon tetrachloride	3.2E-03	6.3E-03	3.2E-07	4.6E-06	5.3E-02	2E-09	2E-08
1,1-Dichloroethene	4.1E-03	8.7E-03	4.1E-07	6.4E-06	1.2E+00	5E-07	8E-06
TOTAL RISK						5E-07	8E-06

(a) Dose for the inhalation of volatiles from showering pathway have been calculated for volatile chemicals of concern with inhalation toxicity criteria. The following chemical is not presented due to lack of inhalation toxicity criteria: sec-butylbenzene.

(b) Average and RME Exposure Point Concentrations were derived using the Foster and Chrostowski (1987) model. These values represent the average air concentration for total shower exposure.

TABLE A-116. NONCANCER HAZARD ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR AIR FORCE PERSONNEL/CONTRACTORS AT FT-2

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (µg/L)	RME EXPOSURE POINT CONCENTRATION (µg/L)	AVERAGE AVERAGE DAILY DOSE (ADD) (mg/kg-day)	RME AVERAGE DAILY DOSE (ADD) (mg/kg-day)	ORAL REFERENCE DOSE (RFD) (mg/kg-day)	AVERAGE HAZARD QUOTIENT	RME HAZARD QUOTIENT
Carbon tetrachloride	0.67	0.81	6.6E-06	7.9E-06	7E-04	9E-03	1E-02
1,1-Dichloroethene	0.70	0.88	6.9E-06	8.6E-06	9E-03	8E-04	1E-03
Manganese	883	2,290	8.6E-03	2.2E-02	5E-03	2E+00	4E+00
Nickel	24	27.7	2.4E-04	2.7E-04	2E-02	1E-02	1E-02
HAZARD INDEX						2E+00	4E+00

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral toxicity criteria. The following chemical is not presented due to lack of oral toxicity criteria: sec-butylbenzene.

**TABLE A-117. CANCER RISK ASSOCIATED WITH THE INGESTION OF GROUND WATER FOR
AIR FORCE PERSONNEL/CONTRACTORS AT FT-2**

CHEMICAL ^(a)	AVERAGE EXPOSURE POINT CONCENTRATION (μ g/L)	RME EXPOSURE POINT CONCENTRATION (μ g/L)	AVERAGE LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	RME LIFETIME AVERAGE DAILY DOSE (LADD) (mg/kg-day)	ORAL SLOPE FACTOR (mg/kg-day) ⁻¹	AVERAGE CARCINOGENIC RISK	RME CARCINOGENIC RISK
Carbon tetrachloride	0.67	0.81	9.4E-07	2.8E-06	1.3E-01	1E-07	4E-07
1,1-Dichloroethene	0.70	0.88	9.8E-07	3.1E-06	6.0E-01	6E-07	2E-06
TOTAL RISK						7E-07	2E-06

(a) Ground water ingestion doses have been calculated for those chemicals of concern with oral cancer slope factors. The following chemicals are not presented due to lack of oral toxicity criteria: manganese, nickel and sec-butylbenzene.

**TABLE A-118. SUMMARY OF NONCANCER HAZARD AT FAIRCHILD AIR FORCE
BASE SITE FT-2**

RECEPTOR/PATHWAY	AVERAGE HI	RME HI
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	2E-03	3E-03
Ingestion of Ground Water	2E+00	4E+00
CUMULATIVE HAZARD INDEX	2E+00	4E+00
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	4E-03	2E-02
Ingestion of Ground Water	3E+00	1E+01
Inhalation of Volatiles During Showering	---	---
CUMULATIVE HAZARD INDEX	3E+00	1E+01

**TABLE A-119. CUMULATIVE CANCER RISK AT FAIRCHILD AIR FORCE
BASE SITE FT-2**

RECEPTOR/PATHWAY	AVERAGE RISK	RME RISK
Air Force Personnel/Contractors		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	4E-09	1E-08
Ingestion of Ground Water	7E-07	2E-06
CUMULATIVE CANCER RISK	7E-07	2E-06
Residential Exposure with Current Conditions		
Inhalation of Soil Particulate	---	---
Ingestion of Soil	9E-09	1E-07
Ingestion of Ground Water	1E-06	7E-06
Inhalation of Volatiles During Showering	5E-07	8E-06
CUMULATIVE CANCER RISK	2E-06	2E-05

APPENDIX B

**RESPONSIVENESS
SUMMARY**

RESPONSIVENESS SUMMARY

#1 COMMENT: Were radioactively contaminated clothes buried at Site SW-12?

RESPONSE: No. Air Force investigations indicate, however, the possibility that radioactively contaminated clothing were disposed in the waste burial trench at Site SW-6. SW-6 is located in the weapons storage area and is being investigated as part of a separate Installation Restoration Program project.

#2 COMMENT: Where is Site SW-12 relative to the Radioactive Waste Burial Trench (Site SW-6)?

RESPONSE: The burial trench at SW-6 is located approximately 4000 feet west of Site SW-12.

#3 COMMENT: Is there a proposed schedule for the demolition of Building 2150?

RESPONSE: The Air Force plans to demolish Building 2150. Due to the availability of funds the demolition is expected to be several years in the future.

#4 COMMENT: What was the disposition of the 1300 cubic yards of soil removed from Site IS-4 during the Remedial Investigation?

RESPONSE: The contaminated soil removed from IS-4 was transported to a low-temperature thermal desorption facility for treatment and final disposition.

#5 COMMENT: Why is enhanced bioremediation, which is commonly considered a cost effective alternative for remediating hydrocarbons, not being considered for the Priority 2 Sites?

RESPONSE: The Air Force did evaluate enhanced bioremediation during the remedy selection process. The "Feasibility Study for Priority 2a Sites at Fairchild Air Force Base" (ICF 1995b) identified enhanced bioremediation, including the addition of nutrients and "engineered" microbes, as an in place technology for remediating hydrocarbon contaminated sites. Enhanced bioremediation for hydrocarbon contaminated sites did not pass the site specific technology screening which included a qualitative assessment of implementability, effectiveness, and cost. The limiting factor was implementability. The use of infiltration galleries and spray irrigation to introduce an oxygen or other nutrient source to the vadose zone is often unsuccessful because the rapid decomposition of the nutrient source precludes effective distribution in the subsurface. Additionally, the need for fluid media to distribute the nutrients to the vadose zone enhances the potential for mobilizing hydrocarbon contamination.

The specific technology referred to by the commenter was reviewed and is not considered unique from the range of bioremediation applications encompassed by the enhanced bioremediation alternative.

- #6 **COMMENT:** Why is enhanced bioremediation not considered for hydrocarbons at IS-4, and PCBs at IS-3?

RESPONSE: For IS-4 the response to comment #5 applies. Because of confining subsurface geometry at this site, the introduction of water, as a carrier media for biologic nutrients, makes implementing an enhanced bioremediation program unfeasible because infiltration of the water is limited to a confined area. Enhanced bioremediation was not considered as an effective method for degrading halogenated compounds such as those encountered at IS-3. This application has produced positive results at some sites but is still considered in the development stage.

- #7 **COMMENT:** Why are institutional controls being considered when technologies are available to cleanup sites? Why monitor for only the short term, then close the site and move on to the next one?

RESPONSE: Institutional Controls are proposed in order to prevent uncontrolled exposures to contamination at these sites. Additionally, long term monitoring programs are proposed to monitor the natural degradation of organic contaminants. Based on the risks posed by the contaminated sites and the nine criteria used to screen and select remedial approaches, the need for an "active" remediation technology was not considered necessary at these sites.

- #8 **COMMENT:** Where does the water in the storm water ditch at Site IS-4 discharge?

RESPONSE: The storm water ditch at IS-4 is designed to discharge to the waste water lagoons located at Priority 1 Site WW-1.

- #9 **COMMENT:** The property owners to the east of the base refer to "No Name Ditch" as the Fairchild Air Force Base Easement.

RESPONSE: The Air Force recognizes the property owners use of the term "Fairchild Air Force Base Easement."

- #10 **COMMENT:** Which aquifer, either the alluvial or basalt, is the contamination at PS-1 impacting?

RESPONSE: Ground water contamination at PS-1 was detected in the alluvial ground water system.

- #11 **COMMENT:** Is there free flowing ground water between the alluvial and basalt aquifers at Site PS-1?

RESPONSE: The Air Force has no evidence indicating ground water flows freely between the alluvial and basalt aquifers at this site.

- #12 COMMENT:** What is the source of data used to describe the thickness of basalt flows beneath the base?

RESPONSE: Approximately 11 ground water monitoring wells penetrating the base of Basalt Flow A have been installed as part of the Installation Restoration Program at Fairchild Air Force Base. Information from these wells has been supplemented with private water well logs provided by the Department of Ecology to determine the approximate thickness of Basalt Flow A. The results are consistent with published studies that report on the regional geology and the nature of the Columbian Basin basalts in general.

- #13 COMMENT:** Why is the basalt at PS-1 described as being encountered between 50 and 200 feet below ground surface when east of the base it is not encountered until greater than 250 feet?

RESPONSE: Geologic data compiled during the Installation Restoration Program shows the depth to basalt varies from 0 feet on the west end of the base to greater than 250 feet near the Craig Road Annex. This data is consistent with the accepted geologic model for the Spokane West Plains and East Central Washington. This model, originally proposed by Harlan Bretz in 1927, theorizes catastrophic flood events scoured large channels (commonly referred to as Coulees) into the basalt in eastern Washington. Evidence to support this theory is seen at Sprague Lake, Grand Coulee, and the Channeled scablands. The area east of the Craig Road Annex is interpreted as a scour channel or coulee that has been filled with alluvial sediments.

- #14 COMMENT:** What is the estimated efficiency of bioventing at PS-1 assuming a JP-4 concentration of 10,000 mg/kg? Are there actual numbers available from the on-going pilot tests.

RESPONSE: An Air Force bioventing study at a JP-4 contaminated site at Tyndall Air Force Base achieved an average hydrocarbon reduction of 2,900 mg/kg over a 200 day period. Initial hydrocarbon concentrations were between 5,100 mg/kg and 7,700 mg/kg. This represents a reduction in total hydrocarbons of 40%. In the Tyndall study a careful evaluation of the relationship to air flow rates and biodegradation and volatilization was made. The study concluded the optimal air flow rate for biodegradation resulted in 90% removal by biodegradation and 10% removal by volatilization. A detailed discussion of the Air Force's bioventing studies is contained in "Test Plan and Technical Protocol for a Field Treatability Test for Bioventing." (EPA 1992). This document may be provided upon request.

At Site PS-1, the Air Force is conducting a pilot test of the bioventing alternative. By measuring the increase in oxygen availability in the soil, the preliminary test results provide the following biodegradation rates:

- Site PS-2 - 510 to 5,100 mg fuel/kg soil/year
- Site PS-1A - 1,800 to 8,300 mg fuel/kg soil/year
- Site PS-1B - 160 to 2,200 mg fuel/kg soil/year
- Building 2034 - 380 to 2,900 mg fuel/kg soil/year
- Building 2035 - 350 to 3,200 mg fuel/kg soil/year

The PS-1 pilot test is ongoing and the preliminary results have not been confirmed. Specific information about these studies can be found in the "Draft Bioventing Pilot Test Interim Results Report" (Engineering Science 1994).

- #15 **COMMENT:** What is the expected percent reduction in hydrocarbon concentrations over a 2 year period using bioventing?

RESPONSE: Based on preliminary results for on-going bioventing programs at PS-1, the Air Force would expect to see a reduction in hydrocarbons ranging from 320 to 16,600 mg of fuel/kg of soil over a 2 year period.

- #16 **COMMENT:** What are the actual costs for institutional controls for contaminated soil at Sites PS-5 and PS-7?

RESPONSE: Projected costs for implementing institutional controls at PS-5 and PS-7 are \$10,150.00 for each site. These costs include implementing the controls, preparing closure documentation, taxes and insurance costs, legal fees, and a 30% contingency.

- #17 **COMMENT:** Why is there a \$14,500 charge for a "No Further Action" alternative at each site? Does the \$14,500 also include costs for government agency involvement in the closure process?

RESPONSE: The cost models used for developing costs for the preferred alternatives are designed to develop qualitative costs that allow the Air Force to compare different remedial alternatives on an equal basis. The \$14,500.00 cost for the "No Further Action" alternative considers closure documentation, legal fees, taxes and insurance, and a 30% contingency. The cost model does not include monies for government agency involvement in the closure process.

- #18 **COMMENT:** What makes the subsurface structure at PS-10 more complicated than the other sites?

RESPONSE: The depositional/erosional setting at PS-10 is directly related to the catastrophic flood events which occurred between approximately 40,000 and 15,000 years ago. These events are collectively referred to as the "Missoula Floods." These floods scoured large channels in the basalt throughout eastern Washington. At PS-10 basalt is found at the surface across some portions of the site and is not encountered until 45 feet at other locations. These radical changes in depth to basalt complicate ground water investigations at PS-10.

- #19 **COMMENT:** What information is available to support the statement that the source of TCE contamination at PS-10 is not attributable to site activities?

RESPONSE: The second bullet in the Priority 2 Sites Proposed Plan (ICF 1995c) under Site Investigation Results is incorrect. The remedial investigation concluded the migration pathway for TCE from soil to ground water was not identified. Based on the TCE concentrations in soil and ground water, the Air Force considers releases from PS-10 the most likely source of the observed ground water contamination, although it is unlikely this contamination is directly from the contaminated area described in the plan. The reference to an off-site location implies the Air Force needs to accomplish additional facility

discovery activities; an action that is unwarranted based on the current understanding of the site. The Air Force considers the potential for TCE contamination in ground water having come from another site as remote.

#20 **COMMENT:** Where does the ditch at PS-10 discharge?

RESPONSE: The ditch at PS-10 discharges to a storm water grate located at the extreme southeast corner of the site, adjacent to the runway. Under normal conditions, however, surface runoff infiltrates to the ground prior to reaching the storm water grate. Chemical data collected during the remedy selection process confirms contaminants infiltrate prior to reaching the storm water system.

#21 **COMMENT:** Is PS-10 a possible source of the TCE contamination observed in "No Name Ditch" and in water wells east of the base?

RESPONSE: The possibility that PS-10 is a source of the contamination observed in "No Name Ditch" is extremely unlikely. Sampling of sediments in the PS-10 ditch shows there is no contamination near the storm water grate that this ditch discharges to. This indicates contaminated surface runoff from PS-10 has not entered the storm water system.

Ground water contamination observed at PS-10 is likely *not* the source for contamination observed in water supply wells east of the base. The distance between PS-10 and these wells is considered too great for transport of the contaminants of concern. Additionally, other areas of contamination are located on the eastern half of the base and are more likely to represent the source of contaminants found in water supply wells.

#22 **COMMENT:** Has ground water beneath the ditch at PS-10 been sampled?

RESPONSE: Yes. Ground water monitoring wells were installed as part of the remedial investigations at this site. Trichloroethylene was detected during each of four sampling events completed between April 1993 and February 1994.

#23 **COMMENT:** Why aren't off-base residents considered when referring to possible exposure scenarios or institutional controls?

RESPONSE: The risk characterization completed during the remedial investigation phase of the remedy selection process evaluated the following human receptor scenarios: Base personnel and contractors, base residents, visitors, trespassers, *and* off-base residents. Institutional controls are exercised over the actual area of contamination and prevent uncontrolled access and exposure to that contamination. The Air Force continues to share information with the local residents regarding potential personal exposure caused by contaminants at the P2 sites.

#24 **COMMENT:** Is the Air Force neglecting retired military personnel residing near the base?

RESPONSE: Fairchild Air Force base has provided routine sampling of water supply wells and has provided alternative water supplies to numerous "neighbors" potentially impacted by ground water contamination attributable to historic base activities.

#25 COMMENT: How long will it take for TCE contaminated ground water to reach newly installed water wells on east side of the base?

RESPONSE: The Air Force does not anticipate, under current conditions, contaminated ground water will impact the newly installed water supply wells located east of the base. Remedial actions currently underway are expected to address this concern. As remediation progresses the Air Force will evaluate its effectiveness and determine if additional measure are needed to mitigate the continued migration of ground water contaminants.

#26 COMMENT: What areas were used for fire training exercises and are all those areas encompassed by site FT-2?

RESPONSE: The Air Force used three areas in the southeastern portion of the base for fire training between approximately the mid-1950s and 1990. FT-2 is only one of these locations and was used from the mid 1950s to the early 1960s. The other two areas are the current fire training site (IRP site FT-1 located at Building 1570), and in an area immediately north of the current fire training site.

#27 COMMENT: Why has no material been provided to the public regarding investigations at the other Fire Training Areas?

RESPONSE: This information was provided to the public during the presentation of the proposed plan for the Priority 1a Sites.

#28 COMMENT: Are there other sites besides the Priority 2 Sites that the Air Force is addressing under the CERCLA process?

RESPONSE: Yes. The Air Force has completed the remedy selection at 8 sites referred to as the Priority 1 sites and will be investigating under the CERCLA process the Priority 3 sites which are as yet to be defined.

#29 COMMENT: Is the Department of Ecology allowing the Air Force to conduct long term monitoring without an active remediation program at the petroleum contaminated sites because Fairchild is a government installation? Would the Department of Ecology allow a private property owner outside the base with the same type of contamination to watch it for 10 or 20 years, without completing an active remediation?

RESPONSE: The long term monitoring program represents more than just a method of watching the contamination. Monitoring is designed to track the biologic degradation of hydrocarbon contamination over time. If monitoring does not show positive results, the Air Force will reevaluate its preferred alternative and look to other techniques for achieving the cleanup action objectives established for individual sites.

Ecology's overall perspective is a concern for groundwater contamination, not as much a concern about the petroleum-contaminated soil in and of itself. In cases where there is petroleum-contaminated soil and no potential groundwater exposures related to that

petroleum-contaminated soil, there is a tendency to not undergo the expenditures for treatment-oriented approaches. This tendency applies to any site (federal or otherwise) similar to the Priority 2 sites. It is not a special opportunity for federal facilities, nor a tendency that applies more to federal facilities than private ones.

- #29 **COMMENT:** Can the Air Force provide a dollar figure for the past 5 years showing what percent of the environmental budget has been spent on taking care of the problem versus how much has been spent on administrative costs?

The Air Force is continuing to compile Installation Restoration Program costs for Fairchild and will provide this information in the Final Record of Decision.

- #30 **COMMENT:** Why did the Air Force put a park where they have cadmium as a contaminant when cadmium is known to cause Lou Gehrig's disease?

RESPONSE: The Air Force identified potential contamination concerns during the development of Warrior Park. Once the concerns were identified, the Air Force took action to mitigate potential exposure while the conditions were investigated. The risk characterization conducted during the remedial investigation concluded there is not an unacceptable adverse human health risk associated with chemical contamination at the park.

Review of the toxicological literature shows there is no relationship between chronic cadmium exposure (which is what would be expected at SW-11) and amyotrophic lateral sclerosis (ALS or Lou Gehrig's Disease).

APPENDIX C

ADDITIONAL SCREENING OF CONTAMINANTS OF CONCERN

ADDITIONAL SCREENING OF CONTAMINANTS OF CONCERN

The following contaminants of concern made it through the initial screening process and were evaluated for risk and hazard at each site. During a meeting at Fairchild AFB in February 1995 with EPA, Ecology, and base representatives, risk management decisions were made to remove several of these contaminants of concern from further consideration in the Priority 2a Feasibility Study report (ICF 1995b). Other contaminants of concern were dropped from consideration for other reasons, as stated in the following text.

SITE IS-3

There is no additional screening of contaminants of concern at IS-3.

SITE IS-4

Soil:

- **Manganese.** This metal occurs naturally in background soils. It is dissolved in reducing environments associated with decay of organic contamination, remobilized by ground water transport, and redeposited along flow pathways where aerobic conditions prevail (see detailed discussion in Remedial Investigation report, Section 2.4.2.5 [ICF 1995a]).

SITE PS-1

Soil:

- **Arsenic.** There were no detections of arsenic above the site-specific natural background levels of 18.9 mg/kg. It was dropped as a contaminant of concern.
- **Beryllium.** There were no detections of beryllium above a basewide natural background levels analysis performed prior to the remedial investigation which showed background beryllium at 0.78 mg/kg. Beryllium was dropped as a contaminant of concern.
- **Manganese.** Refer to the discussion provided for manganese in soil at IS-4.

Ground Water:

- **Arsenic.** Arsenic behaves similarly to manganese by dissolving in reducing environments (Masscheleyn 1991). Refer to the discussion of manganese in soils at IS-4.

- **Manganese.** Refer to the discussion provided for manganese in soil at IS-4.
- **Hexachlorobutadiene.** There was only one detection of hexachlorobutadiene out of 13 analyses at this site. This compound was also detected in an associated trip blank at the site. It is likely a laboratory artifact and was dropped as a contaminant of concern.

SITE PS-5

Ground Water:

- **Arsenic.** Refer to discussion provided for arsenic in soil at IS-4.
- **Beryllium.** There were no detections of beryllium above natural background levels in ground water at this site. It was dropped as a contaminant of concern.
- **Cadmium.** There was one isolated detection of cadmium at 11 $\mu\text{g/L}$ in an unfiltered sample out of 5 analyses, and no detections in any filtered samples. The laboratory detection limit was 5 $\mu\text{g/L}$. The lack of repeatable samples, and the fact that there is no likely source for this contaminant led to a risk management decision to drop it as a contaminant of concern.
- **Manganese.** Refer to discussion provided for manganese in ground water at IS-4.

SITE PS-7

Ground Water:

- **Bromodichloromethane.** Risk calculations showed this compound posed no unacceptable risk or hazard to human health or the environment and so was dropped as a contaminant of concern. It is likely a by-product of lawn irrigation.

SITE PS-10

Soil:

- **Arsenic.** There were no detections of arsenic above natural background levels at the site. It was dropped as a contaminant of concern.
- **Manganese.** Refer to discussion provided for manganese in soil at IS-4.

SITE SW-11

There is no additional screening of contaminants of concern at SW-11.

SITE FT-2

Soil:

- **Arsenic.** There were no detections of arsenic above natural background levels at the site. It was dropped as a contaminant of concern.
- **Methylene Chloride.** There were only 2 detections of this compound out of 44 analyses. The maximum detection was 0.68 mg/kg, and the detection limit was 0.5 mg/kg. A risk management decision was made to drop this compound as a contaminant of concern because there were so few detections and because it was so close to the detection limit.

Ground Water:

- **Manganese.** Refer to discussion provided for manganese in soil at IS-4.
- **Carbon Tetrachloride.** Carbon Tetrachloride was detected in only one well upgradient of the site in only 3 out of 20 analyses. In addition, cumulative cancer risk, to which carbon tetrachloride is the smaller contributor, falls within the acceptable range. As a result carbon tetrachloride was dropped as a contaminant of concern.
- **1,1-DCE.** 1,1-DCE was detected in only one downgradient well and will be addressed in the next phase of the IRP.

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APPENDIX D

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